POWER PLANT ENGINEERING

Established Over 31 Years

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Their Words Carry the Weight of Authority

IN THE DECEMBER 15 issue of Power Plant Engineering which will be The Annual Review Number, this group of eminent engineers will review progress and discuss present tendencies in the power plant industry.

John Hunter, consulting engineer, formerly with the Union Gas and Electric Co. of St. Louis in an article on Boiler Room Practice will trace boiler development from pressures of 200 lb. to those of 650 and 1400 lb.

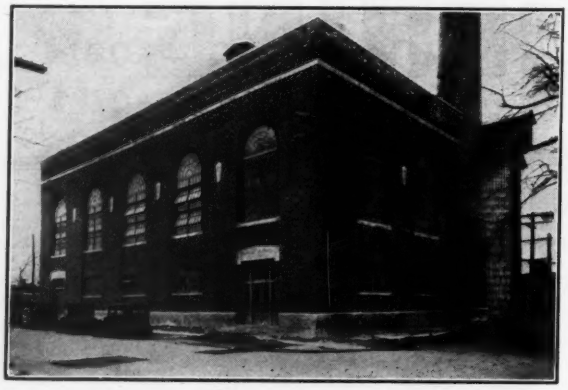
The question of turbine room practice will be covered in an article by James W. Parker, who as chief engineer of The Detroit Edison Co., is well qualified to discuss this subject.

Electrical features will be discussed by R. E. Argersinger, chief electrical engineer of Stone and Webster, Inc., and H. R. Summerhayes of the Central Station Dept. of the General Electric Co., in two separate articles. Mr. Argersinger will take up the electrical side of the power station proper while Mr. Summerhayes will cover the transmission and distribution.

L. F. Harza, consulting hydro-electric engineer of Chicago in an article on Hydraulic Station Practice will present the more important aspects of modern hydro-electric engineering.

Diesel engines are being used at an increasing rate and developments in this field will be fully reviewed by J. G. Oetzel, of the research division of Fairbanks, Morse & Co.

The authors of these articles are all leaders in the respective branches of their profession and they are in intimate contact with the latest developments. Read what they have to say in the December 15 issue for their words carry the weight of authority.



Syracuse University Heated From Central Plant

NEW STEAM PLANT USING PULVERIZED COAL, TOGETHER WITH AN EXTENSIVE NEW STEAM DISTRIBUTION SYSTEM, PROVIDES HEATING FACILITIES FOR MANY YEARS TO COME

SYRACUSE UNIVERSITY at Syracuse, N. Y., has within the past year installed and placed in operation one of the most completely equipped and modern district heating systems of its kind anywhere. This installation includes not only an extensive new underground system of mains, but also an entirely new steam plant burning pulverized coal and equipped with the most modern type of steam generating apparatus. It practically replaces an old system which had served well in former years but which became inadequate as the university grew.

While the original heating station was centrally located, it was built in keeping with architectural consideration of surrounding buildings rather than with the more important economic scheme of operation, and provided only a limited opportunity for supplying increased demand. In the meantime, the university grounds were extended and many adjacent dormitory sites were secured. A large hospital unit with an independent heating plant was also added.

To understand the situation in regard to heating this institution, it is necessary to know something of the topography and the layout of the campus. The university grounds are located on a commanding elevation above the city of Syracuse proper. In extreme weather and at times when there were high winds the old system could not provide sufficient heat for many of the greatly exposed main buildings. Outlying buildings were provided with separate boilers and heaters burning anthracite coal which resulted in ever increasing heating costs and uncertain fuel delivery, plus extra janitor service.

To overcome these conditions and to provide adequate heating capacity to meet future expansion, the Board of Managers secured the services of John L. Graham, consulting engineer, and commissioned him to design and supervise the construction of a new steam generating plant and distribution system.

The old plant, as has been said, was located centrally with respect to the university buildings. However advantageous this may have been for the running of steam lines, this location had no convenient access to a railroad and consequently made the bringing of fuel to the plant a difficult matter. So for the new plant a new site was selected on the D. L. and W. railroad, about three city blocks from the university grounds and 3070 ft. from the old distributing center, which is still used in part. From this new steam plant, which is at the foot of a steep hill, a 10-in. high pressure steam line and a 5-in. return forms the main supply to the university buildings on the hill. No electric power for use in the university buildings is generated at the new station but a small engine-driven generator is installed to supply electricity used in the boiler house only.

The new steam station is an attractively designed structure, built entirely of fireproof material and provided with large windows furnishing abundant natural illumination during the day. It consists of a basement, level with the street and an operating floor with room for overhead coal bunkers and conveying apparatus

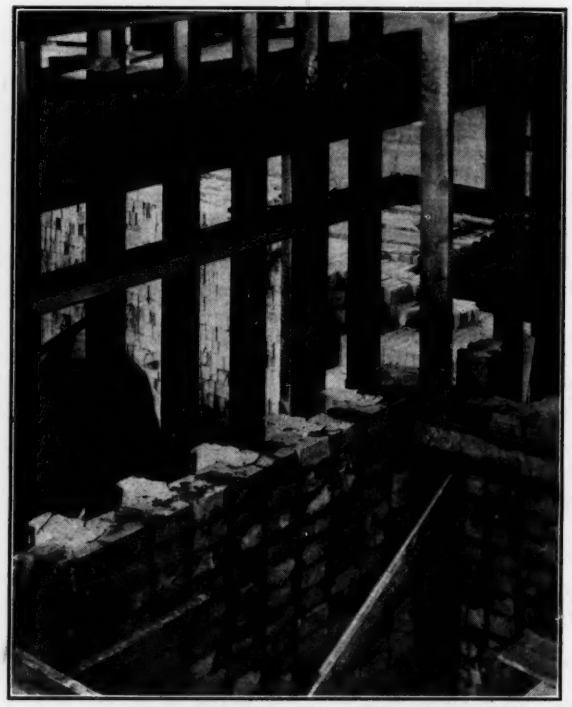


FIG. 1. A PHOTOGRAPH TAKEN DURING CONSTRUCTION TO SHOW THE DETAILS OF THE DE WOLFE FURNACE

above. The exterior is finished in red pressed brick with stone trimmings.

The interior, while not elaborate, is neat in appearance with every provision for the comfort and safety of the operators. All walkways are of subway grating with 2½-in. steel toeboards and provided with sturdy iron pipe railings. The windows are of plain glass set in steel sash. The floors are of concrete and the roof of concrete slabs laid on steel framing. Robertson ventilators on the roof keep the air in the station in a comfortable state.

Two 600-hp. Connelly, Class M-22 boilers are installed. These are equipped with Foster superheaters, and are designed for a working pressure of 200 lb. and

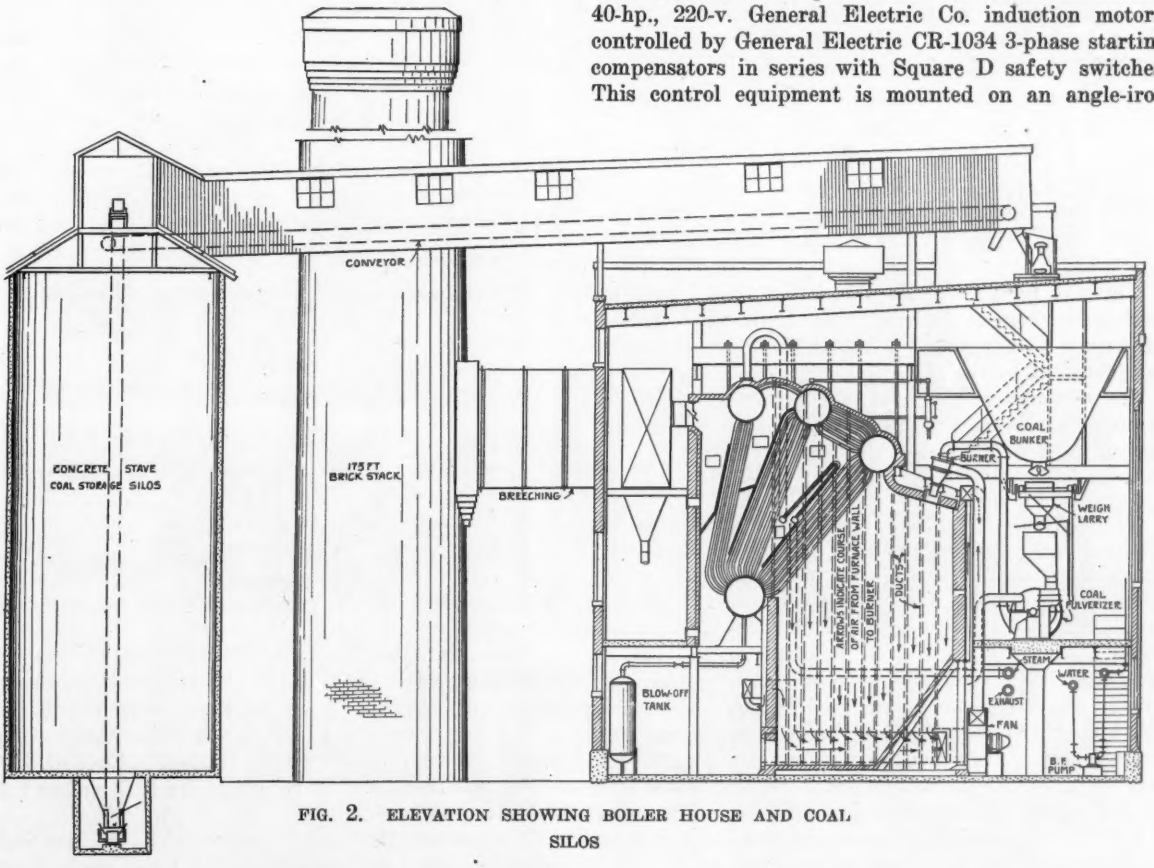


FIG. 2. ELEVATION SHOWING BOILER HOUSE AND COAL SILOS

to operate at 300 per cent of their rated capacity. They are set in DeWolf furnaces with 4200 cu. ft. volume and are arranged for pulverized coal firing using the Riley Atrita system. The construction of the DeWolf furnace wall will be described in greater detail later, but for those not familiar with the type of furnace it may be well to state here that it is an air-cooled wall employing a number of vertical ducts on the exterior of the furnace walls through which the air for combustion passes on its way to the furnace. This furnace wall construction was developed by R. D. DeWolf of the Rochester Gas and Electric Corporation. Those at the Syracuse University were installed by the Wm. Summerhays Sons Corp. of Rochester.

Three Atrita pulverizing units are provided, two of which are motor driven and the other steam driven. These have capacities of about 500 lb. per hr. each and are installed on the operating floor immediately in front of the boilers as may be noted in Figs. 3 and 5C. There is a motor-driven unit for each of the two boilers, each supplying two burners. The steam-driven Atrita which is placed between the two motor-driven units is arranged so that it can supply either or both of the two boilers. Each boiler is fitted with three burners, two of which are supplied from the motor-driven Atrita associated with that boiler and the third (the center burner) from the steam-driven pulverizer. With this arrangement the steam-driven pulverizer can carry both or one of the boilers at light load or it can help to carry the peak load on any or both boilers when the occasion demands.

The motor-driven pulverizers are direct connected to 40-hp., 220-v. General Electric Co. induction motors, controlled by General Electric CR-1034 3-phase starting compensators in series with Square D safety switches. This control equipment is mounted on an angle-iron frame attached directly to the concrete motor foundation. The steam-driven unit is direct connected to a Lee Type B B steam turbine rated at 50 hp. and operating at 1200 r.p.m. under a steam pressure of 150 lb. and with 1 lb. back pressure.

Coal Handling System

Coal is stored in three concrete-stave silos located in the back of the boiler house. The coal is dumped from railroad cars into a track hopper and crusher and is then delivered to a pivoted bucket conveyor which in turn delivers it into the tops of the silos. If coal is not intended for storage, instead of delivering into the silos the pivoted bucket conveyor delivers to a belt conveyor installed at right angles to the bucket conveyor which carries the coal over the top of the boiler house

roof, as shown in the accompanying illustrations. As the coal reaches the end of this belt it passes over a magnetic separator for the removal of tramp iron onto a drag conveyor, the latter delivering into any part of the overhead storage bins in the boiler room.

To withdraw coal from the storage silos, it is dropped by gravity through coal valves in the bottom of the silos into the lower run of the pivoted bucket conveyor and transported to the boiler room in the manner described. The pivoted bucket conveyor travels a rectangular path over the tops and underneath the silos. All belts and conveyors are operated by General Electric induction motors, and are protected from the weather by sheet steel enclosures.

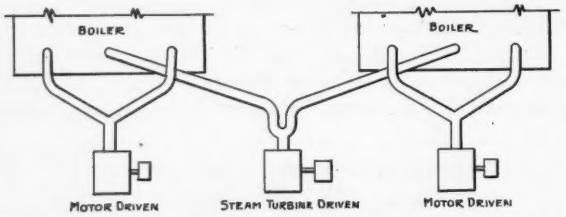


FIG. 3. THE 3 PULVERIZERS ARE ARRANGED AS SHOWN BY THIS SKETCH

The silos have a storage capacity of 1580 t. and the overhead bunkers in the boiler room 150 t. The crusher can handle 40 t. per hr. All coal handling equipment was furnished by the Link-Belt Co.

Delivery of coal to the pulverizing units is made by means of a traveling weigh larry, which automatically records the weight of each charge.

Boiler Equipment

As may be noted from Figs. 2 and 6, the boilers are of the 4-drum water tube type with the superheater located directly behind the first tube bank. The entire boiler is suspended from overhead steel beams by wrought iron straps passing around the ends of the drums. All tubes are 3¼ in. in diameter and are set with alternately wide and narrow spaces so that any tube in the boiler can be removed without interfering with any other tube. The feed water is introduced into the rear upper drum and flows down through the rear bank of tubes into the bottom drum where it mixes with the hot water coming down through the middle bank of tubes. The water then passes up through the front bank of tubes into the front upper drum which is entirely filled with water and then on through the second bank of tubes into the center upper drum, where the steam is liberated. From here the hot water again passes down through the center bank of tubes to the bottom drum and again passes through the same path. The steam that has been liberated into the center upper drum is not drawn from that drum but is passed through the steam drying tubes to the upper rear drum. From here it passes to the superheater and out to the boiler header.

Each boiler is equipped with the following apparatus: Yarway tandem blowoff valves, Vulcan soot blowers, Reliance water columns, Copes feed water regulators, American Schaeffer and Budenberg Corp. safety valves and Crane Co. automatic stop and check valves.

The construction of the DeWolf furnaces, indicated in Figs 1 and 4, makes use of specially designed refractory bricks—a key brick which is clamped to the vertical steel supporting beams, and the furnace bricks which, when in place, form the furnace walls. This construction, it will be noted, forms a number of vertical ducts on the outside of the furnace, between the vertical steel columns. A sheet steel casing is fitted to the outside of the supporting columns to close the ducts.

Air for combustion is drawn into these ducts at the top of the side and rear walls of the boiler and in passing downward abstracts heat from the furnace walls. In the basement this warm air passes into a tapered horizontal duct on the sides of the furnace from which it is drawn by the forced draft fans and delivered under pressure to the pulverized coal burners. About 10 per cent of the air for combustion enters the burner mixed with the coal, the balance is drawn through the setting.

Air is also heated in the floor of the furnace. This is drawn into ducts installed in the floor, running directly from front to back as shown in Fig. 7, and at the rear is turned through 180 deg. and returned to the front where it is collected in a tapered chamber and finally drawn into the Atritas. This air is used for drying the coal as it passes through the pulverizers.

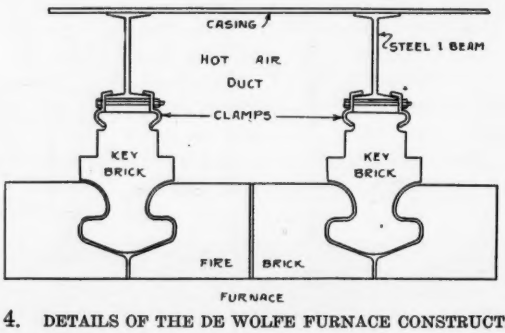


FIG. 4. DETAILS OF THE DE WOLFE FURNACE CONSTRUCTION

From this description it will be apparent that the entire furnace is air-cooled. The DeWolfe blocks are supported vertically by a steel plate every fourth tier so that any section can be removed without disturbing the other blocks. With a total furnace volume of 4200 cu. ft., this furnace gives 0.7 cu. ft. for each square foot of heating surface.

Two forced draft fans are provided, one for each boiler. These are installed in the basement and are Green Fuel Economizer Co. units with a capacity of 12,000 c.f.m. and are driven direct by 10.3-hp., 3-phase, 220-v. General Electric induction motors. They are two speed motors, running either at 1180 or 580 r.p.m. Control is by General Electric CR-1034 starting compensators and Square D safety switches.

A radial brick stack, 175 ft. high, with a diameter of 9 ft. at the top is built on a separate foundation just back of the building. This was built by the Wm. Summerhays Son Corp. of Rochester. The steel breeching was furnished by the Ames Iron Works of Oswego.

Feed water obtained from the city mains is treated by a Cochrane hot process (lime-soda) softening apparatus having a capacity of 8000 gal. per hr. The sedimentation tank and heater is installed on a platform above the operating floor at one end of the boiler room

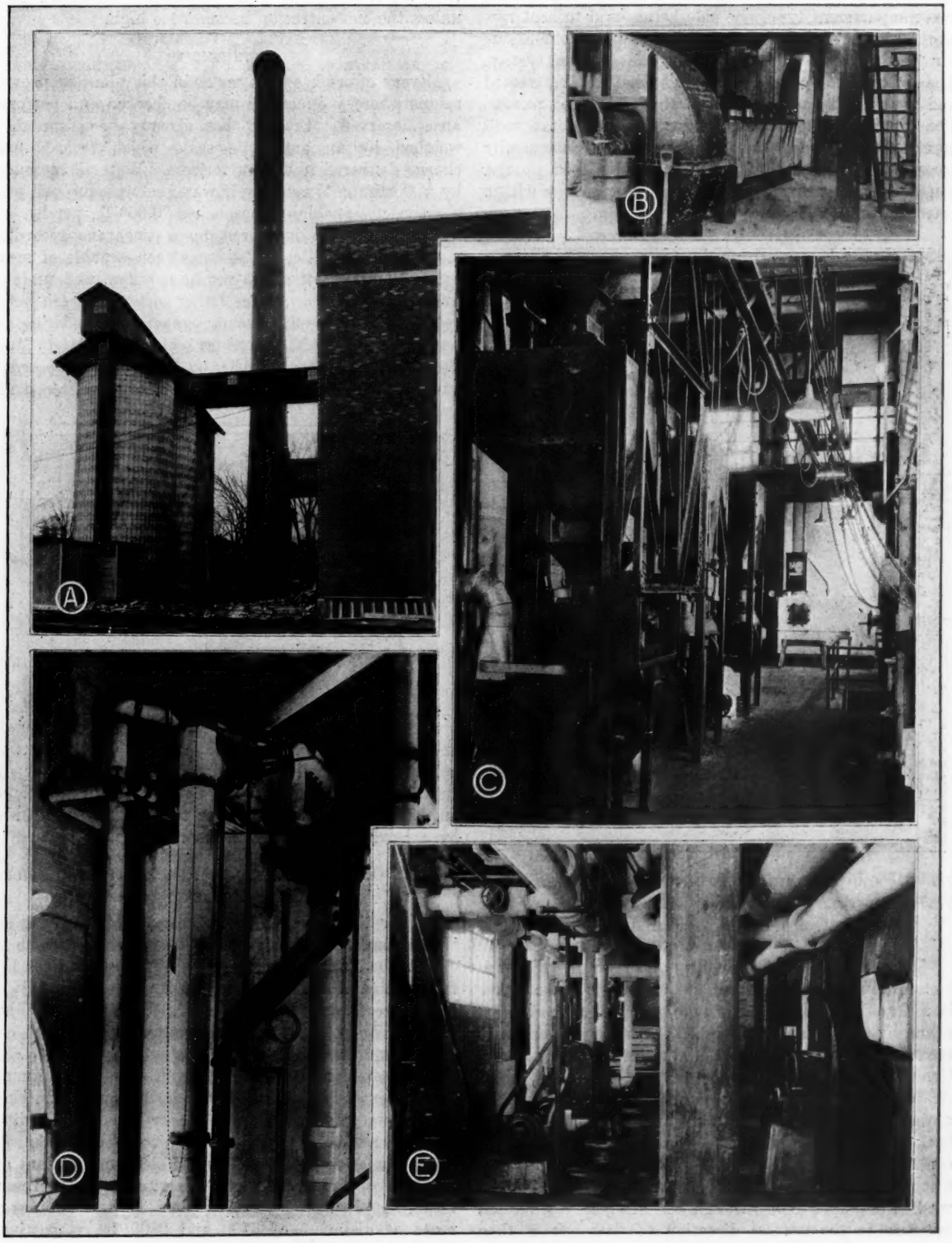


FIG. 5. VIEWS OF THE NEW CENTRAL HEATING PLANT AT SYRACUSE UNIVERSITY, SYRACUSE, N. Y.

A. Coal is stored in three concrete-slab silos which are connected to the boiler house by an overhead belt conveyor. B. A corner of the basement showing the air heating ducts along the furnace wall. C. The three coal pulverizers are conveniently placed in front of the boilers on the operating floor. D. The sedimentation tank with the double compartment feed water heater on top. E. A view showing the forced draft fans.

while the chemical proportioner and mixing tank is placed in the basement. The heater is of the deaerating two compartment type, one side being used to heat raw city water intended for treatment and the other side for heating the condensate from the heating system. The latter is, of course, pure and need not be treated and from the heater passes directly to the feed pumps. The raw water after being heated passes to the sedimentation tank and after being treated chemically passes through a sand filter to the boiler feed pumps. The filter is a Cochrane unit of the pressure type with a rated capacity of 8 gal. per sq. ft. per min.

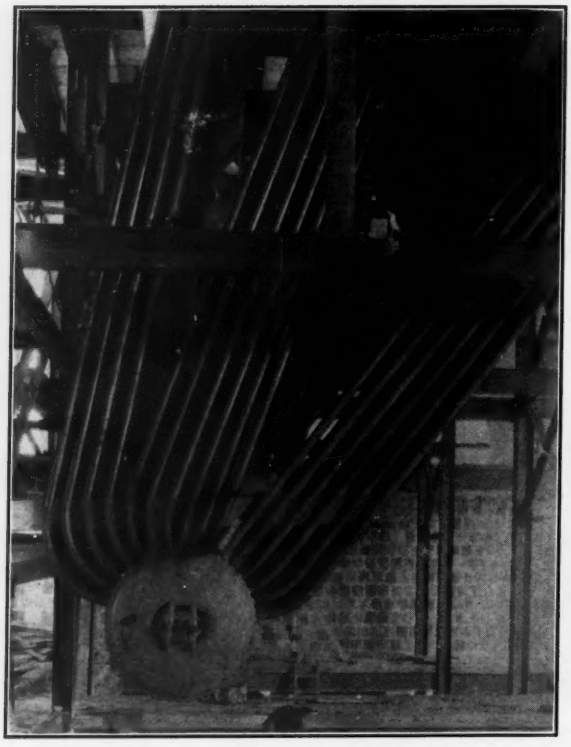


FIG. 6. SHOWING THE LOCATION OF THE SUPERHEATERS. A THERMOMETER WELL CAN BE SEEN JUST BACK OF THE RIGHT HAND OPENING OF THE SUPERHEATER

There are three boiler feed pumps, two of which are motor driven and the other steam driven. The latter is a Goulds, 3-stage centrifugal pump driven at 2500 r.p.m. by a 45-hp. Lee turbine. The motor-driven units are also Goulds, but are 6-stage and are driven by 25-hp. General Electric induction motors.

In addition to the feed pumps there is also installed a wash pump used for cleaning the softener and for back washing the filter. This is a 700-g.p.m. Goulds centrifugal, motor-driven pump. In backwashing the filter, water is drawn from the softener tanks by the wash pump and sent through the filter in a direction opposite to the normal direction of flow. It is then delivered back to the treating tank where the suspended matter removed from the filter is allowed to settle and is drawn off as sludge in the usual manner. This arrangement is not only convenient but saves a considerable amount of heat. The feed water enters the boilers free from oxygen at a temperature of a little over 200 deg. F. Daily analysis of the actual boiler water controls the treatment and the boilers are not blown down unless the concentration becomes too high.

Instruments

Every effort has been made in this plant to provide means whereby operation may be checked and performance observed. Coal, it has already been stated, is weighed by an automatic scale which records each charge delivered to the pulverizers. Water is measured by a Cochrane V-notch weir water meter equipped with a recorder, capable of measuring 70,000 lb. per hr.

Steam flow is measured by a Cochrane recording meter on each boiler. These are each capable of measuring 50,000 lb. of steam per hour when used under a pressure of 160 lb. Bailey boiler meters on each boiler record steam pressure, steam temperature and flue gas temperature; draft is masured by four Bailey Multi Pointer draft gages and CO_2 by Ranarex CO_2 recorders on each boiler. The draft gages record furnace draft,

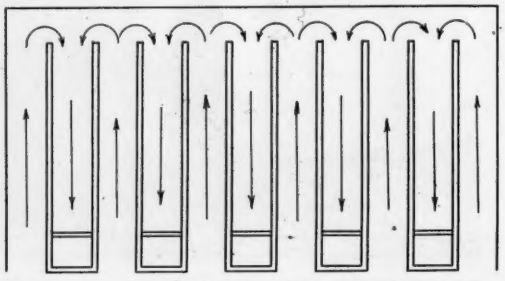


FIG. 7. SKETCH SHOWING PRINCIPLE OF DUCT CONSTRUCTION IN FURNACE FLOORS

uptake draft, left duct pressure, center duct pressure and right duct pressure. The draft gages for both boilers and the boiler meters are all mounted on a panel just opposite the boiler fronts with the steam flow meters on each side. The feed water temperature is recorded by a Foxboro recording thermometer.

Small Generator Supplies Electricity for Boiler House

While this is primarily a central steam heating station, a small generating unit is provided to furnish the current used in the boiler house. This is an Ames Uniflow engine of the 3-cylinder vertical type, size 10½ by 9 in., direct connected to a General Electric Co. 125-kw., 240-v., 375-amp., 60-cycle alternator, with direct connected exciter. This unit is installed in a separate room in the basement together with all control equipment. The latter consists of a 2-panel switchboard, consisting of one generator panel and 1 feeder panel. In addition to this engine it is of interest also to know that the engine-generators installed in the old campus plant and in the bospital power plant are run by high pressure steam supplied from the new plant. These engines operate at distances of 3700 and 2800 ft., respectively, from the new boilers.

Ample space has been provided for the installation of additional equipment if future demands make that necessary. The two boilers comprising the present installation only occupy one-half the building, leaving room for two future units. The coal handling equip-

ment is adequate to handle the requirements of such future boilers.

Steam Distribution System

The American District Steam Co., contractors, installed the underground steam distribution system. Ample size underground mains, steam supply and water return lines extend to the center of the university grounds and radiate in reduced sizes to all buildings, including two hospitals in the university group. The steam mains convey steam at 125 lb. and 100 deg. superheat to all points for power and high temperature purposes, being reduced for low pressure steam heating. At the power plant a Foster reducing valve reduces the steam from 165 lb., which is boiler pressure, to 125 lb. for delivery to the mains.

All condensate is returned, mostly by gravity, to the boiler plant which is situated at the extreme low point in the system. Underground line losses are reduced to a minimum by the application of one 1½-in. layer of

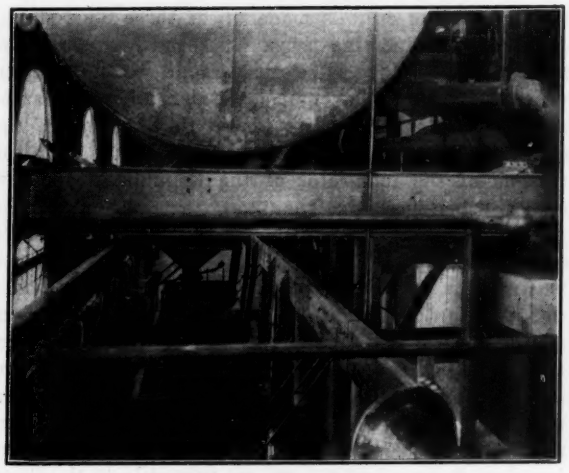


FIG. 8. COAL IS DISTRIBUTED FROM THE OVERHEAD BUNKERS INTO THE PULVERIZER HOPPERS BY A TRAVELING WEIGH LARRY

moulded magnesia covering and one layer of 1½-in. Johns-Manville sponge felt, telescopically applied and enclosed in a water-proof jacket. This covered main is housed on top and sides with multicell tile, Am. Dist. Steam Co. system, set in Portland cement mortar on a 4-in. concrete base with two drain tile lines and clean crushed stone beneath to prevent any accumulation of water in the soil surrounding the underground conduit.

Standard weight wrought iron pipe for steam and extra heavy wrought iron pipe for water was installed with electric welded steel flanged ends where flanged fittings occurred; all other pipe joints were oxyacetylene welded. All sections were tested to 300 lb. hydraulic pressure before the covering was applied. Special expansion joints of long traverse in roomy manholes provide for expansion requirements, with anchor points secured by specially welded anchors set in concrete. Special pipe bends and built-up welded angles were supplied and all services and return laterals were welded off the top of the main lines. Valves are set in at junction points in the mains and where services are connected. A rust proof paint was applied to all iron surfaces and copper wire was used at 8-in. intervals in binding on the water-proof jacket. Automatic traps are set in manholes at intervals in the main steam line and at low points in the buildings.

This distribution system, together with the new steam plant, provides for all heating needs of the university in an up-to-date, economical manner.

Since this plant was placed in service in March of this year it has made an excellent performance record. During the summer, when the average load on the plant was 200 hp., only 33 per cent of the boiler rating, the average overall efficiency of the plant was 76 per cent.

On May 17, 18 and 19 a thorough evaporative test was run on the plant by Coleman & Co., Inc., and the results checked and approved by John L. Graham, the consulting engineer. In carrying on these tests every care was taken to assure their reliability and the tests were carried on under regular operating conditions at such ratings required to meet the normal demand.

While the complete data collected in this test is extremely interesting, because of space limitations we are able to present here only the summary in the form of the heat balance tabulation. The per cent of rated capacity developed by the boilers on May 17-18 and May 18-19 was 130 and 114 per cent respectively.

Results of Tests on May 17, 18 and 19

Heat Balance	May 17-18 B.t.u.	May 17-18 Per Cent	May 18-19 B.t.u.	May 18-19 Per Cent
Heat absorbed by water in boiler	10,127	76.7	10,164	76.9
Heat absorbed by steam in superheater	537	4.1	578	4.4
In boiler and superheater	10,664	80.8	10,742	81.3
Heat lost in products of combustion	1275	9.7	1249	9.4
Heat lost due to excess air	296	2.2	367	2.8
Heat lost in steam from burning of hydrogen in coal	438	3.3	437	3.3
Heat lost from moisture in coal	25	0.2	25	0.2
Heat lost from CO in flue gas	53	0.4	61	0.5
Heat lost by carbon in ash and flue dust	26	0.2	26	0.2
Heat lost in radiation and unaccounted for	426	3.2	301	2.3

In concluding this description we acknowledge our indebtedness to John L. Graham, the consulting engineer, for his assistance and many courtesies extended in the course of gathering the material used in its preparation.

Goggles are essential for humanitarian and economic reasons. The first needs no explanation. The second is answered by losses in the states of Pennsylvania and New York alone. How about the remaining 46 states?

New York paid out in compensation $1,703,235.00 for eye accidents last year, and assuming that compensation payments to employes constituted only 20 per cent of the total cost of accidents to the employer, these accidents cost the state $8,516,175.00 in twelve months. In Pennsylvania 6842 eyes were destroyed from 1916 to date. Included in this figure are 175 cases in which both eyes were lost. From January 1, 1927, to date, 383 eyes were totally destroyed in various types of industry from coal mining to restaurants. In the year 1925, Pennsylvania paid out $886,599.00 in compensation alone. Conservatively speaking, this represents an economic loss of about $5,000,000.00.

Boiler Losses Reduced by Proper Instructions

Bonus Based on Four Preventable Boiler Losses Gave Incentive Which Raised Efficiency 7 Per Cent. By Charles G. Klopp

IN THE FIRING of boilers, the four preventable losses can be controlled by the promotion of the competitive incentive in human nature. The installation of the necessary guiding information, in an easily available manner, promotes the competitive instinct prevalent in all of us, and the results are rewarded in the form of pay as a bonus.

Curves and charts, submitted with this article, have been used in practice, and the information derived therefrom posted for the guidance and benefit of the firemen with excellent results. This method places the technical education of the combustion engineer at the disposal of his crew. Thus we have the combustion engineer, not as a boss, but in a helpful and advisory capacity.

DATA AND RESULTS

SHIFTS	7 A.M. to 3 P.M.	3 P.M. to 11 P.M.	11 P.M. to 7 A.M.	Current Average 1 month
Steam Press., lb. per sq. in.	236	235	235	233
Steam Temperature, Deg. F.	515	510	510	512
Feed Water Temperature, Deg. F.	187	188	186	191
Factor of Evaporation	1.150	1.146	1.148	1.144
B.T.U. of Coal as fired	13500	13800	13500	13000
Coal burned per hr., lb.	19320	21500	20000	19450
Actual Evaporation per hr., lb.	180000	174000	173000	164500
Equivalent Evaporation per hr., lb.	207000	208000	198000	188500
Equiv. Evaporation per lb. of Coal	10.70	9.49	9.90	9.70
PER CENT COMBINED EFFICIENCY	76.8	69.7	72.3	72.4
PREVENTABLE LOSSES---PER CENT OF COAL FIRED				
Excess Air	0.5	(8.3)	2.2	
Incomplete Combustion	0.0	0.0	0.0	
Flue Gas Temperatures	0.2	0.5	0.3	
Combustible in Refuse	0.7	2.0	(5.0)	

EFFICIENCY RECORD IS 77.2 PER CENT

BY ROGERS DATE MARCH 12, 1927

FIG. 1. FORM USED FOR DAILY PERFORMANCE RECORDS

Show your boiler room operators where they are wasting coal, instruct them how to eliminate the various losses that occur in converting coal energy into heat energy, then offer an incentive for the elimination of these losses; the result must be a higher overall boiler plant efficiency. In working out details for the most successful results from the method, careful considerations must be given to the type of equipment, as well as the type of men connected with each individual plant.

At present, the method is being used in two boiler plants, of which the writer is in charge. One of these consists of four 823-hp. Stirling boilers fired by forced draft, underfeed stokers. The second plant consists of 22 boilers, 14 are 316-hp. Heines fired by Murphy stokers, six are 316-hp. Heines fired by Taylor stokers, and two are 600-hp. Connellys fired by Taylor stokers. In the plant consisting of the four Stirling boilers, Richardson automatic scales were installed between the bunker and stoker hoppers, then the method applied in April, 1926, with the result of an increase in the yearly average combined efficiency of 7.1 per cent. The average efficiency for the year 1925 was 63.5 per cent, while for 1926 it was 70.6 per cent.

In the second plant, consisting of 22 boilers, there is no coal weighing apparatus, therefore coal is charged against the plant according to railroad car weights. The method was, however, started without the purchase of any additional equipment, about the middle of January of this year, with a result of an efficiency of 67.4 per cent for the month of January, and an efficiency of 70.6 per cent for the month of February. The yearly average for the year 1926 was 66.2 per cent, accordingly results following the application of the method in this plant are very satisfactory.

Briefly, the description of how the method is applied to the Stirling boiler plant, follows: The total boiler plant operating crew is made up of three 8-hr. shifts. At each shift changing period, the head fireman of the shift going off duty is required to fill out a form, on which is reported the condition of all mechanical equipment, and on which is also placed the readings of the counters of the Richardson automatic scales and the reading of the integrator of the Republic steam flow meter, which measures the total steam output of the plant. The head fireman of the shift coming on duty checks this report, as well as scale and meter readings, and if the report is satisfactory to him, signs his name, this being an indication that he assumes further responsibility for the condition of equipment. This arrangement has been found very helpful in placing the blame for an avoidable breakdown on one man and furthermore eliminates the greatly favored scheme of "passing the buck" when investigations are started. Each morning these boiler plant reports are turned in at the steam plant office, together with charts giving the steam pressure, feed water temperature, etc., and from this data a daily boiler plant performance report is made out, a copy of which is posted on the bulletin board in the boiler room, not later than noon.

Figure 1 is the form used for these daily performance records. It is to be noted that this report covers the record of each 8-hr. shift, pointing out the four preventable losses in per cent of coal fired. Here lies the secret. Point out to the firemen where they are losing coal, instruct them what should be done to eliminate these losses, placing particular stress on the one greatest loss, and they will save coal. They will even hunt for leaks in the settings, and paste them up immediately, because the efficiency bonus plan offers the incentive. Bonus is paid on the combined boiler efficiency at the end of each month, this bonus being based on a percentage of the money saved on coal by the increase in boiler plant efficiency.

A set of curve sheets has been worked out by the writer, in order to facilitate the problem of determining the four preventable losses: 1. Excess air. 2. Incomplete combustion. 3. Excessive flue gas temperatures. 4. Combustible in the refuse.

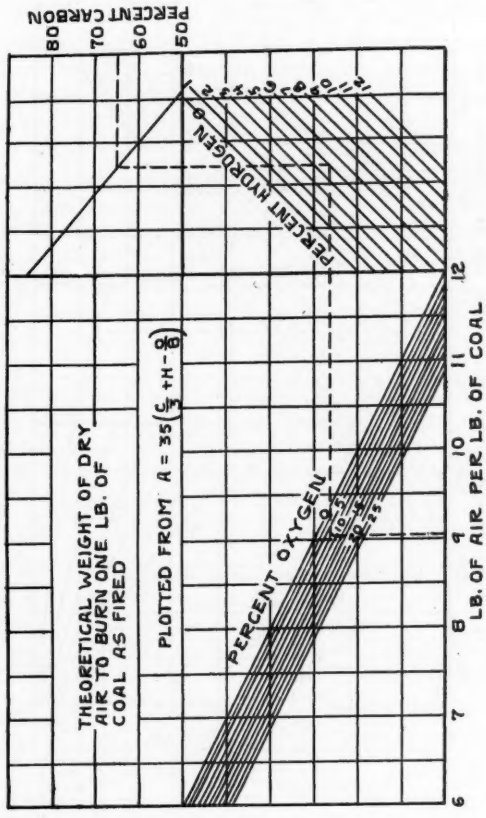

PERCENT CARBON
PERCENT HYDROGEN
PERCENT OXYGEN
THEORETICAL WEIGHT OF DRY AIR TO BURN ONE LB. OF COAL AS FIRED
PLOTTED FROM $A = 35\left(\frac{C}{3} + H - \frac{O}{8}\right)$
LB. OF AIR PER LB. OF COAL

FIG. 2

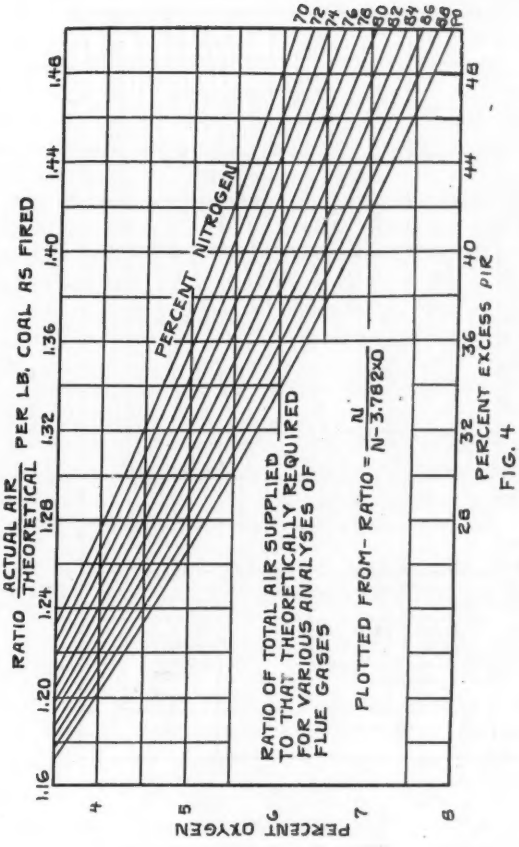

RATIO ACTUAL AIR / THEORETICAL PER LB. COAL AS FIRED
PERCENT NITROGEN
RATIO OF TOTAL AIR SUPPLIED TO THAT THEORETICALLY REQUIRED FOR VARIOUS ANALYSES OF FLUE GASES
PLOTTED FROM- RATIO = $\frac{N}{N - 3.782O}$
PERCENT OXYGEN
PERCENT EXCESS AIR

FIG. 4

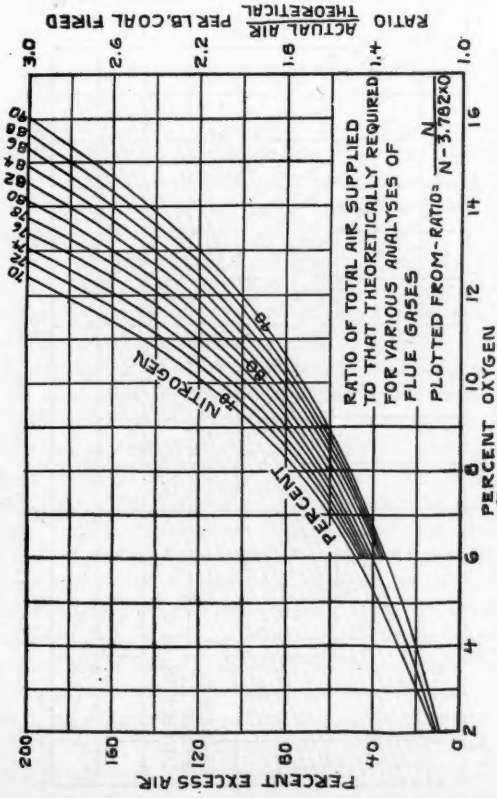

RATIO ACTUAL AIR / THEORETICAL PER LB. COAL FIRED
PERCENT NITROGEN
RATIO OF TOTAL AIR SUPPLIED TO THAT THEORETICALLY REQUIRED FOR VARIOUS ANALYSES OF FLUE GASES
PLOTTED FROM- RATIO = $\frac{N}{N - 3.782O}$
PERCENT OXYGEN
PERCENT EXCESS AIR

FIG. 3

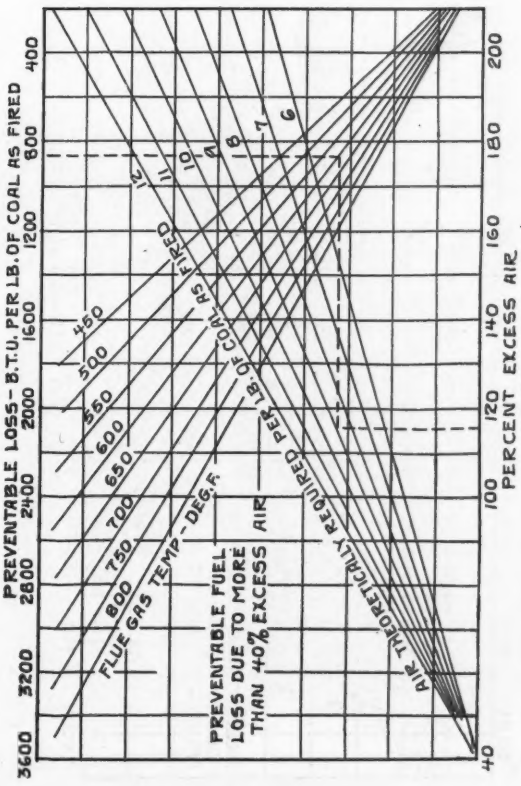

PREVENTABLE LOSS - B.T.U. PER LB. OF COAL AS FIRED
PREVENTABLE FUEL LOSS DUE TO MORE THAN 40% EXCESS AIR
FLUE GAS TEMP - DEG. F.
AIR THEORETICALLY REQUIRED PER LB. OF COAL AS FIRED
PERCENT EXCESS AIR

FIG. 5

PREVENTABLE LOSS - B.T.U. PER LB. OF COAL AS FIRED
PREVENTABLE FUEL LOSS DUE TO INCOMPLETE COMBUSTION
B.T.U. = C 10160 CO / CO2+CO
PERCENT CO IN FLUE GAS
PERCENT CARBON IN COAL
PERCENT CO2 IN FLUE GAS

FIG. 6

PREVENTABLE LOSS - B.T.U. PER LB. OF COAL AS FIRED
CALORIFIC VALUE OF COMBUSTIBLE - B.T.U.
PREVENTABLE FUEL LOSS DUE TO COMBUSTIBLE IN REFUSE
PLOTTED FROM - B.T.U. = h/100 (Ya/100-Y)
PERCENT ASH IN COAL AS FIRED
PERCENT COMBUSTIBLE IN DRY REFUSE

FIG. 8

PREVENTABLE LOSS - B.T.U. PER LB. OF COAL AS FIRED
PRODUCTS OF COMBUSTION LB. PER LB. OF COAL FIRED
PREVENTABLE FUEL LOSS DUE TO EXCESSIVE FLUE GAS TEMPERATURE
STEAM PRESS. LB. PER SQ. IN. GAGE
FLUE GAS TEMP. - DEG. F.

FIG. 7

CALORIFIC VALUE OF ONE LB. OF COMBUSTIBLE - B.T.U. (000)
CALORIFIC VALUE OF ONE LB. OF COAL AS FIRED - B.T.U.
PERCENT MOISTURE IN COAL
CALORIFIC VALUE OF COMBUSTIBLE
PERCENT ASH IN COAL AS FIRED

FIG. 9.

Figures 2, 3, 4, and 5 show the curve sheets used in determining the loss in B.t.u. per pound of coal fired due to the use of more than 40 per cent excess air.

Figure 6 is the curve sheet used in determining the preventable loss due to incomplete combustion.

Figure 7 is the curve sheet used in determining the loss due to excessive flue gas temperatures. The assumption, that flue gases should leave a boiler not over 150 deg. F. above the temperature of saturated steam corresponding to the pressure carried by the boiler, was made in working out this set of curves.

Figures 8 and 9 are the two curve sheets required in determining the preventable loss due to combustible in the ash.

Before attempting to apply the method, considerations must be given towards the establishment of a system for the collection of the following data: 1. Analysis of the coal. 2. Analysis of the ash. 3. Flue gas analysis. 4. Steam pressure carried in the boiler. 5. Temperature of the gases leaving the boiler. Having this

BOILER BLOW-DOWN RECORD FOR THE MONTH OF MARCH

BOILER NO. A

Maximum Concentration allowable is 300 Grs. per Cal.

Date	Grs./Cal.	11 P.M.–7 A.M. Shift			7 A.M.–3 P.M. Shift			3 P.M.–11 P.M. Shift		
		Blown	Time Blown	Blown By	Blown	Time Blown	Blown By	Blown	Time Blown	Blown By
1	150	/	12:05 4 Min.	Fore	/	8:20 4 Min.	Regan	/	6:15 4 Min.	Dawes
2	140	/	1:20 4 Min.	Fore	/	7:30 4 Min.	Regan	/	5:30 4 Min.	Dawes
3	120	/	12:10 4 Min.	Fore	/	7:35 4 Min.	Regan	/	4:20 4 Min.	Dawes
4	100	/	12:30	Fore	—			/	5:00	Dawes
5	100	—			/	8:20	Regan	—		
6	90	/	12:20	Fore	—			/	4:30	Dawes
7	90	—			/	8:00	Regan	—		
8	100	/	12:00	Fore	—			/	4:00	Dawes
9	110	/	12:20	Fore	/	8:15	Regan	/	3:45	Dawes
10										
11										
12										

FIG. 10. MONTHLY BLOW-DOWN RECORD

data and the set of curves before you, it becomes a simple matter to determine the four preventable losses in per cent of coal fired. On each curve sheet appears a dotted line, indicating the path to follow to arrive at an answer to the problem.

Having determined the losses, it is simply necessary then to give the firemen instruction concerning the meaning of each preventable loss and steps that should be taken for the elimination of the losses. The plan quickly brings to attention the good and bad firemen, as well as the points on which each particular fireman is weak.

Firemen will burn coal efficiently when it affects their bonus at the end of the month, and so will they blow down the boilers efficiently, provided they have some information about boiler blow-down regulation. Where water credited to them is measured by means of a steam flow meter, firemen are likely conveniently to forget about blowing down boilers, then, of course, the concentration runs high and there are maintenance costs in the engine room that might offset savings, supposed to have been made in the boiler room. On the other hand, blowing down too often is a direct waste of coal.

Figure 10 is a form used for a daily record of the concentration of water in each boiler. It is to be noted that one boiler may be blown down two or three times as often as another, in order to keep the concentration practically the same in all boilers. The concentration determinations are made right in the boiler room, by means of a small instrument known as the "Klo-Cru" meter. This instrument, which has just recently been put on the market, is found to be very simple to operate, and accurate for all practical purposes.

The writer firmly believes, and this belief has been fostered and strengthened by a wide experience with the type of men who form boiler house crews, that information, a knowledge of what they are doing, and the results they achieve, is an incentive to increased efficiency. The monetary reward is tangible evidence of good work done, and its cost is but a small fraction of the amount in dollars and cents saved to the management, by the increased efficiency obtained.

An incentive to work, a broader vision of results of effort, and a suitable reward, these three things represent workmen with an object and such workmen are of great value to any organization.

Burning Bark That Contains 35 Per Cent Moisture

WASTE FROM WOOD ROOM OF THILMANY PULP & PAPER CO., BURNED WITHOUT DRYING, DEVELOPS 450 HP. FROM 250-HP. VERTICAL WATER-TUBE BOILER

BURNING OF BARK without first drying it is a problem that often confronts the engineer of an industry using large quantities of wood from which bark

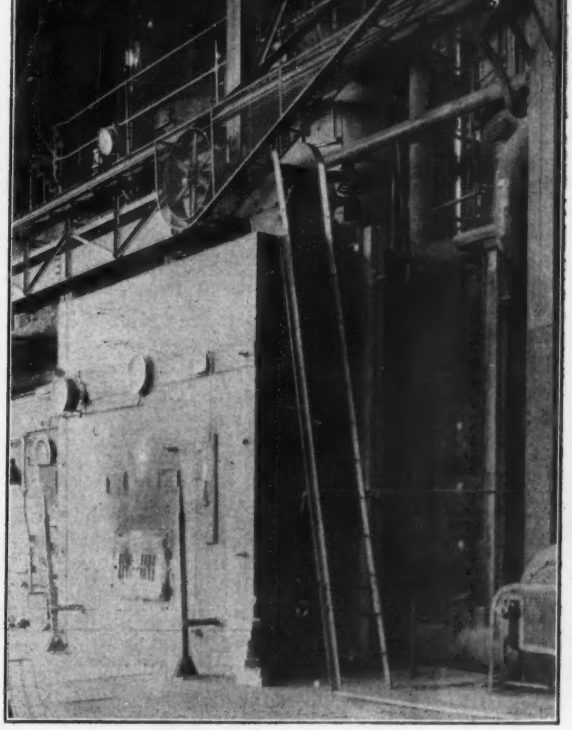


FIG. 1. THIS BARK-BURNING FURNACE UTILIZES BARK FROM 150 CORDS OF WOOD A DAY

is a waste product, as in the paper industry. At one of the boiler plants of the Thilmany Pulp & Paper Co. at Kaukauna, Wis., however, the problem has been solved successfully. Here, in a specially designed furnace installed with a 250-hp. Wickes vertical water-tube boiler, the bark is burned from 150 cords of wood used every day by the paper mill. This quantity of bark operates the boiler for about 14 hr. Good combustion of the fuel is brought about by the admission of air through the furnace walls at suitable points and in sufficient amounts. This arrangement permits the boiler to operate at an average of 400 hp., about 160 per cent of rating. As the bark contains, at times, as much as 35 per cent of moisture and as the output of the boiler when burning this bark has often been increased in 3 min. from 100 hp. to 425 hp., some details of the setting to produce this result may be of interest.

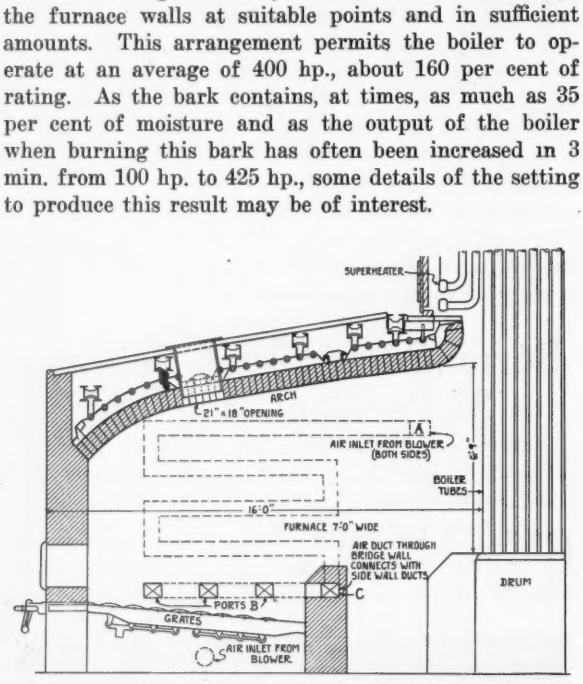


FIG. 2. AIR FOR COMBUSTION IS SUPPLIED THROUGH VENTILATED SIDE AND BRIDGE WALLS

Figure 1 is a view of the exterior of the furnace and Fig. 2 is a section showing its construction. The Wickes boiler makes steam at 160 lb. pressure, 75 deg. of superheat being added by a Foster superheater as shown. A Green economizer serving this boiler and three other Wickes coal-fired boilers, raises feed water temperature to about 200 deg.

The furnace itself is a modified Dutch oven type, having side walls of A. P. Green fire brick, a Detrick flat suspended arch as shown and Cyclone grates, set with a bridge wall. Each side wall of the furnace has an air duct as shown. The walls consist of 9 in. of brick then the 5-in. air space and then a 4-in. brick wall inside, the latter being reenforced along the ducts by De Mattia chrome wire netting, anchoring to 4-in. wall to the outside wall. Air supplied by a motor-driven Boston forge blower to the two side walls, entering at A, passes through the air space in the walls, where it is preheated and also ventilates the walls; then it enters the combustion chamber on each side at B. Some of this air is also led through a duct C in the bridge wall to ventilate it and is admitted to the furnace over the grate. Air is supplied under the grate by a Buffalo fan.

Bark is brought from the wood room of the mill by the Jeffrey conveyor shown above the furnace and is dropped directly onto the grates. After the fire is started, therefore, little attention is necessary except to regulate the air supply to correspond with the amount of fuel fed. The arch aids ignition and also enables the fire to be brought up quickly if it has been allowed to burn low for any reason.

Draft gage, pressure gage and indicating flow meter are mounted on the furnace front as shown. It is not known exactly what the combustion conditions are in this furnace, as no tests have been run on it. It is believed that they are good, however, since flue gas leaves the economizer at about 525 deg., the boiler operates normally at about 160 per cent of rating and the fuel used to do this is moist bark, which would otherwise be wasted.

The above bark-burning furnace was designed and built under the supervision of Chas. R. Seaborne and Charles W. Spahr, superintendent of power for the Thilmany Pulp and Paper Co.

High Efficiency Maintained in Industrial Plant

CHOICE OF BOILER ROOM INSTRUMENTS CONSIDERED FACTOR IN SECURING EXCELLENT OPERATING RECORDS. BY HOWARD W. MORGAN*

THAT BOILERS in industrial power plants can be operated so as to attain overall efficiencies comparing favorably with central station practice, is demonstrated by the results obtained at Lockport, N. Y., in the boiler room of the Upson Co., manufacturers of wallboard. This boiler plant consists of four 350-hp. Wickes vertical water tube boilers, fired with Combustion Engineering Co. Type E stokers. The uptake dampers and the fan engine are controlled by means of a Ruggles-Klingemann regulator actuated by the steam pressure while the windbox pressure is regulated from the over-the-fire draft by means of a Carrick control apparatus.

TABLE I. DATA OBTAINED DURING THE BOILER TEST

Coal Quality and Ash Analysis	
Moisture	1.65 per cent
Volatile matter	35.75 per cent
Fixed carbon	55.57 per cent
Ash	7.03 per cent
	100.00 per cent
Sulphur	1.25 per cent
B.t.u. as fired	13,700
Unburned carbon in refuse	17.45 per cent
Observed data:	
Average flue gas temperature	535 deg.
Average CO_2	11 per cent
Average steam pressure	155 lb. gage
Average feed water temperature	212 deg.
Average boiler rating	142 per cent
Total weight of coal burned, 24 hr	115,380 lb.
Total water evaporated, 24 hr	1,212,500 lb.
Average evaporation, actual	10.51 lb.
Average evaporation, from and at 212 deg.	10.99

Coal fed to the stoker hoppers is weighed by a traveling larry and the water fed to the boilers is measured

*Director of Research, Pittsburgh Coal Co.

by a Venturi meter. Each boiler is equipped with a Bailey boiler meter showing the steam flow, air flow and flue gas temperature. There are no economizers and no provision for preheating the combustion air. The steam is used to drive an engine to furnish electric power and the engine exhaust is used in the driers. Condensate is returned to the boilers.

Recently a test was run on these boilers to determine their performances with prepared stoker coal which is sized over vibrating screens to remove the fines ordinarily present in slack to $\frac{5}{16}$ by 1 in. and in addition is air cleaned so as to be practically free from slate and extraneous impurities. From coal samples and data taken during this test the figures in Table I were obtained.

From the foregoing data it is possible to calculate an approximate heat balance. In order to obtain the average excess air percentage from the Bailey meter charts to calculate the dry flue gas loss, analyses of the flue gases from each boiler were made with an Orsat and the positions of the meter pens noted at each reading. The average of 11 per cent CO_2 shown above was estimated by examination of the charts at the end of the run guided by the flue gas analyses taken over a comparatively short period. This figure may, therefore, be in error but probably by not over 1 per cent, which would change the dry flue gas loss by 1.4 per cent.

Ash Samples Carefully Taken

The refuse sample was unusually large and carefully taken and prepared so that it should be truly representative of the actual refuse removed. The calculated loss of heat due to unburned carbon in the refuse at this plant checks very closely with that obtained at a number of other plants where this grade of coal has been burned and may be considered reasonably accurate. Inasmuch as the overall efficiency figures shown in Table II was obtained from the actual coal and water weights, the exact amount of the other losses is not essential except as a check against these weights, that is, if a reasonable looking heat balance is obtained it is fairly certain that the coal and water weights were accurate and that the efficiency of the boilers is close to the figure obtained.

TABLE II. HEAT BALANCE BASED ON COAL AS FIRED

Heat absorbed by boilers (from coal and water weights)	77.8	per cent
Dry flue gas loss	13.5	per cent
Loss due to unburned carbon in refuse	1.7	per cent
Loss due to moisture and hydrogen in coal	4.2	per cent
Radiation and unaccounted for losses (by difference)	2.9	per cent
	100.00	per cent

It will be noticed that the figure for radiation and unaccounted for losses, obtained by subtracting the sum of the other items in the heat balance from 100 per cent, is 2.9 per cent. This seems a reasonable figure for boilers operating at 142 per cent rating. It may be in error by one or two per cent on the low side. Taking everything into consideration, the approximate heat balance looks reasonable and probably the figure obtained for overall efficiency, heat absorbed by the boiler, is accurate within one or two per cent. Methods showing how the various figures were obtained are given at some length because whenever high overall efficiency figures are given for this type of plant there is nearly always some doubt as to their accuracy in the minds of other engineers.

Test Made by Regular Crew

No preparation whatever was made for this test and no instructions were given to the firemen as to the handling of the coal during this run. Nobody except the regular boiler room force was in the boiler room except for a few hours on the day shift while the flue gas analyses were being made. Examination of the boiler records shows that these results are typical of the normal operation of the plant except as the losses are affected by higher ash, lower heat coals. With the usual slack, both the dry flue gas and refuse loss would be higher.

No one instrument or piece of equipment is responsible for the high efficiency with which the coal is burned at this plant. The works manager, F. J. Rooney, and the chief operating engineer, J. R. Rawling, realize wisdom of keeping records on boiler operation and knowing every day exactly what results the men are getting. The firemen have the instruments they need to guide them in getting good combustion and have sufficient control apparatus to make this an easy task.

It would be difficult to say whether any one meter or piece of regulating equipment has paid for itself in this plant, but the difference between the kind of operation they are getting and just fair results, such as found in a large number of plants where the management had not taken the same keen interest, means a saving of from 2600 to 4300 t. of coal per year. This is based on their burning approximately 17,000 t. of coal a year, with an overall efficiency of 75 per cent. At 65 per cent overall efficiency it would require 19,600 t. of the same quality coal to produce the same amount of steam. At 60 per cent overall efficiency, it would require 21,300 t. The efficiency of the boilers in many industrial power plants falls in this range of from 60 to 65 per cent. This company is getting a very fair return on the money spent in supplying the means of obtaining good combustion control and performance records and the time required for keeping the records and from them directing the boiler room force.

Calculating Extraction Turbine Performance

In the above article by K. S. Kramer, in our Oct. 15 issue, several discrepancies have been discovered which readers should correct in their copies. On page 1075, in Fig. 1, the flow through the trap from No. 3 heater to No. 2 heater should be 50,760 lb. per hr. instead of 56,760 lb. per hr. In the last paragraph of the left-hand column, page 1075, the third line from the bottom should read ". . . the total heat per lb. of steam, H = 1365 B.t.u." On page 1076, right-hand column, in the table under heading Heat of Liquid of Mixture Entering Heater, the last item should read:

"Heat of liquid of mixture $(Q'' + Q''') \div (F + M) . q$"

Appurtenances for Use with 1200-Lb. Boilers

PROBLEMS CONNECTED WITH THE CONTROL AND OPERATION OF BOILERS AT HIGHER PRESSURES HAVE BEEN SOLVED SUCCESSFULLY WITHOUT ENCOUNTERING THE DIFFICULTIES EXPECTED

BECAUSE of the high pressure, drums and water storage spaces of boilers operating within the range of 1000 to 1500 lb. per sq. in. must be small. It is therefore necessary that the control of steam and fuel be sensitive and dependable in order to remove any element of danger, either to the operators or equipment.

Four high pressure boilers are now in service in this country, two industrial, and two central station units, while two more are under construction. At Lakeside

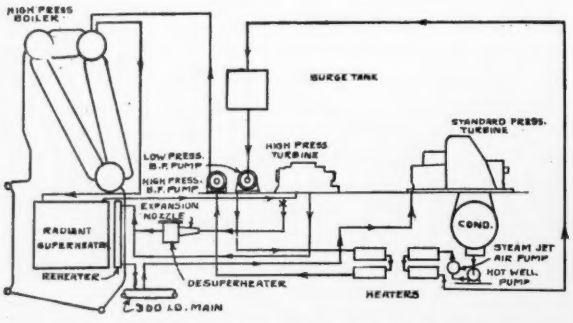


FIG. 1. DIAGRAMMATIC ARRANGEMENT OF PIPING AND APPARATUS IN A HIGH PRESSURE STATION USING RADIANT SUPERHEATERS AND RESUPERHEATERS

station, the 1300-lb. boiler unit of the three drum bent tube type is the highest pressure unit in operation in this country, although this will soon be surpassed by the two 1400-lb. straight tube type boilers now under construction for the Edgar Station. Development in this country has been along conventional lines in contrast to European progress in this direction, as exemplified by the complicated Benson, Leffler and Atmos boilers.

It is, of course, not practical to expand steam from such high pressures down to condenser pressure in a single unit. Steam is therefore expanded from 1200 to 300 or 400 lb. in a high pressure unit, then reheated and expanded to condenser pressure in a standard pressure turbine. Figure 1 is a typical layout utilizing the high pressure unit. Exhaust of the high pressure turbine after reheating goes to the standard pressure steam header to be used in any of the standard pressure units. In this case both the reheating and superheating units are of the radiant type but the straight tube boiler now in service have both convection superheaters and reheater coils.

Evaporation of the storage water in a boiler of this kind occurs two or three times an hour at normal rating so that the feed water supply is a serious consideration. Figure 2 shows the control board of a 1300-lb. installation. Feed water regulation in this case is by hand through the throttle valve A and by watching the steam flow and water flow meters the operator has little difficulty in keeping the water level constant. Because of the piping arrangement these meters can be placed in the standard pressure piping system and still give accurate indications of the flow through the high pressure part of the installation.

SPECIAL WATER GLASS IS PROTECTED FROM CHEMICAL ACTION BY MICA

Because of the fact that the water gage glass is about 30 ft. above the operating floor a periscope indicated by D in Fig. 2, is of great assistance. This periscope arrangement was described fully on page 842 of the August 1 issue. The water level when viewed through this periscope is more distinct and more easily visible than when looking at the bare gage glass. Experience with high pressures shows that the tubular gage glasses were not entirely satisfactory for the higher operating pressures due to chemical action of pure feed water on the strength of the glass and difficulties of properly packing them. Flat plate and fluted glass were found

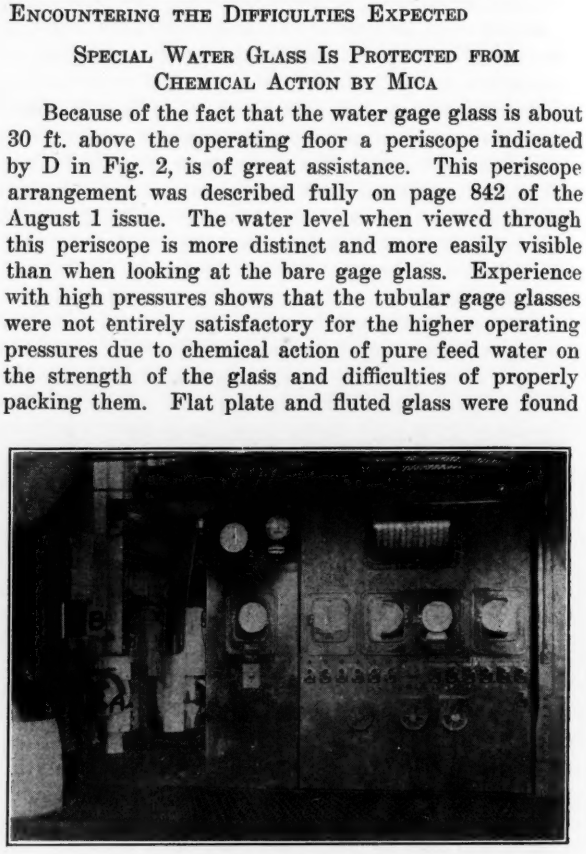


FIG. 2. VIEW OF THE CONTROL BOARD OF THE HIGH PRESSURE BOILER AT LAKESIDE STATION

to be better, but still suffered from the same chemical and packing difficulties. Double flat glasses, protected by mica were not affected by the chemical action, but could not be packed steam tight without breaking.

Experiment led to the design of the glass shown in Fig. 3. This has been tested up to pressures of 1650 lb. and given satisfactory service. The body comprises a central holder and two covers, each slotted vertically. In the recess of each space of the holder is first placed a gasket, then a sheet of mica, and on that a thin brass gasket. In the recess of each cover is placed first a gasket, then a bar of glass approximately 0.7 in. thick. When the parts are bolted together, only the boiler pressure can come on the glass, and this glass is protected from chemical action by the mica. A thin brass gasket seals the edge of the joint between the cover and the glass. In service the glass lasts indefinitely, but the gaskets and mica need renewal or cleaning in from 4 to 6 weeks. Two or more fittings at different elevations can be used on the same column when considerable difference in water levels must be indicated. The double tube gage shown in the lower right-hand corner of Fig. 3 is a new development for high pressures. The tubes are forged of special bronze, attached to the tip and socket by screw joints without the use of solder.

Except for emergency service, the high pressure

boiler feed pumps take their suction from the standard pressure feed water headers, thus making it necessary to pump only against the pressure differential between the two systems. One interesting pump design for this service is made with two distinct pump casings, the inner one being surrounded by an outer shell or casing which is subjected to the standard water pressure, leaving the inner casing subjected, not to the full pressure, but to the pressure differential between the standard and high pressure feed systems.

In an installation now being considered, there will be two motor driven pumps used for normal operation with a third turbine driven unit installed for emergency service. Each motor driven pump will consist of three pumps in series, two 5-stage volute pumps and one 6-stage service pump. One 5-stage volute pump of each unit will be driven by a separate motor and will pump through two closed feed water heaters delivering water at 500 lb. per sq. in. 420 deg. F. to the section of the second 5-stage volute pump. The second 5-stage volute pump and the service pump will be piped in series driven by one motor and will discharge at a maximum pressure of 1600 lb. per sq. in. All motors will be adjustable speed and will be automatically regulated. The turbine-driven pump will also be a six-stage turbine unit and will develop the full 1600 lb. per sq. in. in one casing. This pump is designed for automatic starting when the pressure in the 1600-lb. boiler feed header drops below a predetermined safe limit.

Requirements for Feed Water Regulation Severe

Due to the diminishing ratio of water storage space in the boiler to the actual steam delivery of the boiler, the requirements for feed water regulation have become very severe. The modern high pressure feed water regulator must not have any lag in its operation and must be instantaneous in its action. The water level in the boiler must also be held constant for all load conditions. Although automatic feed water regulation was not considered practical when high pressure units were first put in service, regulators have been perfected and have been giving satisfactory operation for many months. The operating unit of one type of regulator is shown installed on a boiler drum in Fig. 4-G, the small pipe marked A in this figure is connected to the valve in the feed water line similar to Fig. 4-D. This valve body is cast without flanges, the flanges being put on later, using a heavy buttress thread. The castings are X-rayed and subjected to a 5000-lb. hydrostatic test in addition to a test where the valve is subjected to 1500 lb. pressure on one side and atmosphere on the other.

Figures 4-A and 4-E show the external and internal construction of another feed water regulator valve. This valve, also of the double ported type, has a special port arrangement whereby the flow through the valve can be controlled to meet the characteristics of the individual installation. That is, the flow can be made proportional to the lift, can be made so that there is a small flow at low lift or large flow at low lift, as desired. The valve is an extremely important part of the system, and it is necessary that it be of the tight feeding design so that water leakage past the valve during light load conditions will not require hand regulation to keep from flooding the boilers and damaging the turbine equipment.

Even on lower pressures it is becoming standard practice to use or maintain a constant excess pressure on the feed water regulator, and this is of increased importance in the higher pressure units of small water storage space where the operation of the feed water regulator assumes increased importance. Two regulators, designed especially for this heavy duty, are shown in Figs. 4-B, C and F. The one in Fig. C, shown being tested in Fig. 4-F, is of the hydraulic type where a plunger is used to move drum controllers of the motor for motor-driven pumps, or a simple type throttling valve in the steam supply line to a turbine driven pump. It can be used as a master regulator with one regulator used to control two or more units, either steam or electrically-driven, or a combination of such units. The excess pressure regulator, 4-B, is practically a self-contained unit easily installed with an absence of packing, pilot valves and auxiliary operating apparatus.

Safety Valves Have Caused No Trouble

Boilers must, of course, be protected by safety valves in accordance with the A. S. M. E. boiler code. Two

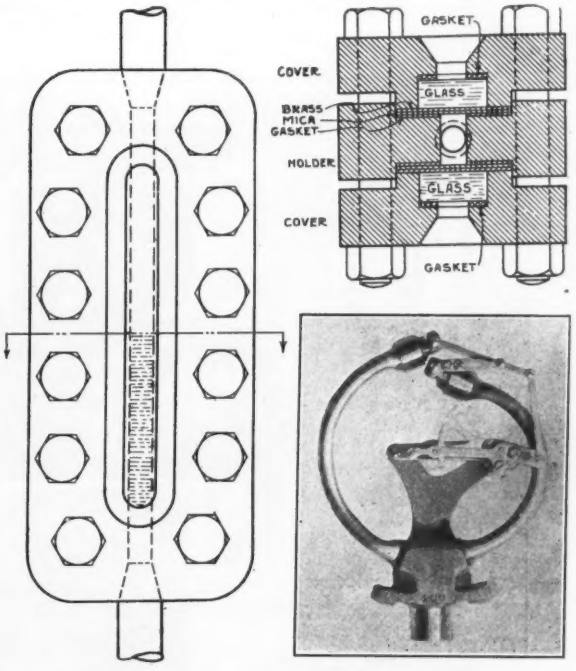


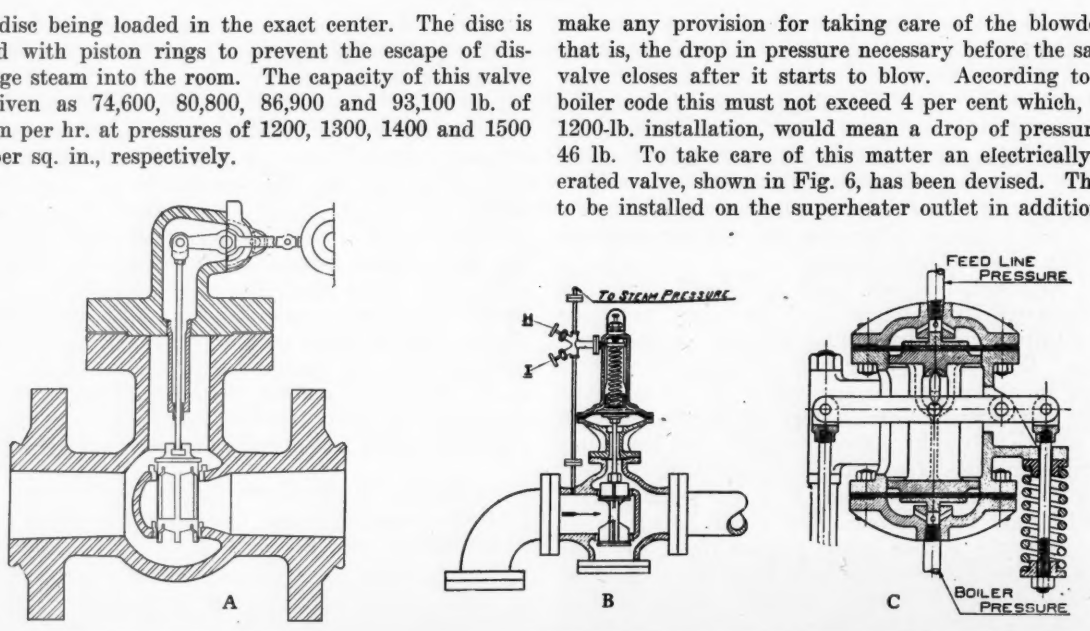
FIG. 3. DETAILS OF CONSTRUCTION OF A MODERN WATER GLASS AND PRESSURE GAGE DESIGNED FOR HIGH PRESSURES

types of valves which have been developed and proven satisfactory for this high pressure service are shown in Fig. 5. The one on the left is known as the nozzle type. The nozzle and disc are the only parts under steam pressure, the body of the valve serving merely as a spring support and as a casing to carry off the discharge steam. The nozzle is independent of the body, the joint between the boiler and the valve being made directly against the flange face of the nozzle. The parts are symmetrical, the nozzle is without obstruction with the disc entirely top guided.

Both the nozzle and disc are forged of high nickel chrome steel. Contact between the spindle and the disc is made by a hardened steel ball imbedded in the spindle and a hardened steel cup washer on the disc, insuring

the disc being loaded in the exact center. The disc is fitted with piston rings to prevent the escape of discharge steam into the room. The capacity of this valve is given as 74,600, 80,800, 86,900 and 93,100 lb. of steam per hr. at pressures of 1200, 1300, 1400 and 1500 lb. per sq. in., respectively.

make any provision for taking care of the blowdown, that is, the drop in pressure necessary before the safety valve closes after it starts to blow. According to the boiler code this must not exceed 4 per cent which, in a 1200-lb. installation, would mean a drop of pressure of 46 lb. To take care of this matter an electrically operated valve, shown in Fig. 6, has been devised. This is to be installed on the superheater outlet in addition to



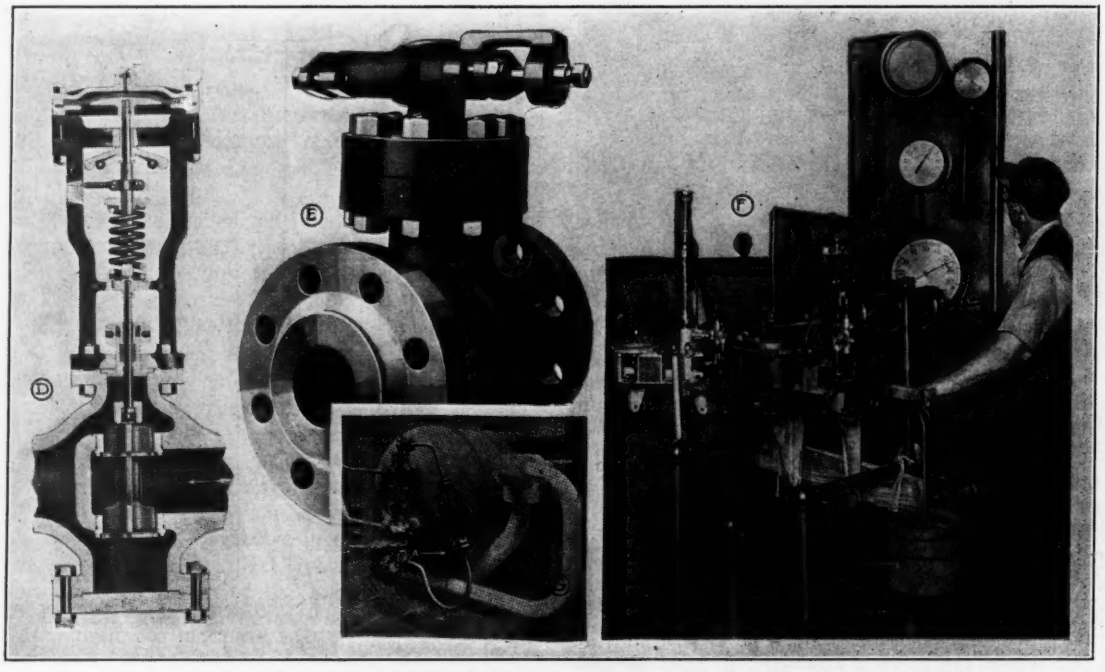


FIG. 4. A AND E EXTERNAL VIEW AND CROSS SECTION OF FEED WATER REGULATOR VALVE, DESIGNED WITH SPECIAL PORTS SO THAT THE FEEDING CHARACTERISTICS CAN BE CONTROLLED. D. FEED WATER VALVE CONTROLLED BY THE APPARATUS INSTALLED ON THE BOILER DRUM IN G. C. ONE TYPE OF DIFFERENTIAL PRESSURE REGULATOR FOR USE ON BOILER FEED LINES. F. A REGULATOR OF THE TYPE SHOWN IN C BEING TESTED BEFORE SHIPMENT. B. ANOTHER TYPE OF EXCESS PRESSURE REGULATOR DESIGNED FOR HIGH PRESSURE SERVICE

Construction of the valve on the right is evident from a cross sectional drawing. This valve has special seat bushings with stiffening sections or rings alternating with weaker sections for slight distortions that take place in the valve body before they reach the seat, a heavy toggle joint lifting gear with the top cap bolted to the yoke and a completely exposed or ventilated spring.

These standard blowdown valves do not, of course, the regular safety valve. It is set to open a few pounds below the other valves and, being electrically operated, the blowdown can be controlled within any desirable limit, usually ½ to 1 per cent or 6 lb. on a 1200-lb. unit. The capacity of the valve is such that it will take care of all normal operating conditions and none of the other safety valves will be called upon to open.

The valve can be operated automatically through the electrical contact shown in the upper right-hand corner

of Fig. 6, or it can be operated by hand, as desired. A control box is mounted in a convenient place near the other instruments on the boiler room floor. At 1500 lb. the valve has a capacity of 163,000 lb. of steam per hour and the steam is discharged from two opposite flange outlets so that the reaction of the discharging steam jets will balance each other. This discharged steam can be piped to the standard pressure system.

Turbine Throttle and Bypass Valve Operate Simultaneously

Control of the fuel is important and in the installation shown in Fig. 2 the pressure gage on the independent panel is equipped with electrical contacts which automatically cut off some of the coal burners when a predetermined pressure has been reached. If the pressure continues to rise the remaining burners are cut off, thus giving full protection against excessive pressure in the boiler drums. In case the turbine throttle valve emergency tripped a second oil or water-controlled valve in the bypass line is opened simultaneously, bypassing steam from the high pressure system through a reducing nozzle and desuperheater into the steam line entering the reheater. The nozzle, desuperheater and separator are shown in Fig. 7. The desuperheater with the separator is connected to the outlet end of the nozzle, and the water flowing to the desuperheater is controlled by a standard temperature regulator and diaphragm valve. The 12-in. desuperheater shown is designed to handle 240,000 lb. of steam per hour at 350 lb. pressure, reducing the temperature from 725 deg. to saturation temperature.

This desuperheater is necessary in order to protect the reheater from excessive temperature for, although the high pressure steam could be sent through the nozzle directly into the standard pressure steam header without excessive temperature and without the use of the desuperheater, this would mean the bypassing of the reheat element entirely, subjecting it to the full furnace temperature without giving any method of cooling.

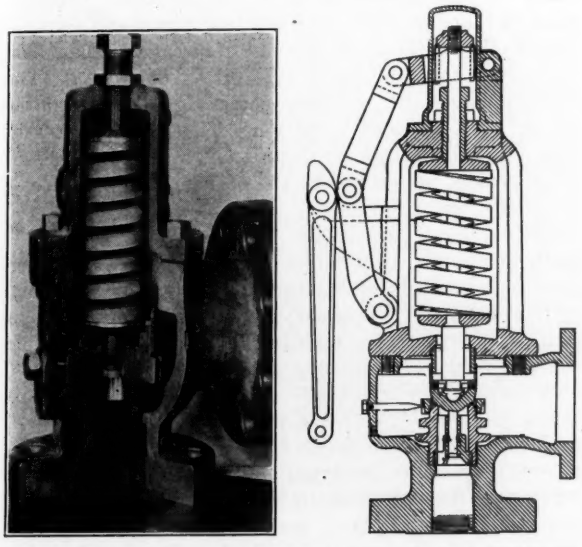


FIG. 5. TWO TYPES OF SAFETY VALVES THAT HAVE PROVEN SATISFACTORY IN OPERATION

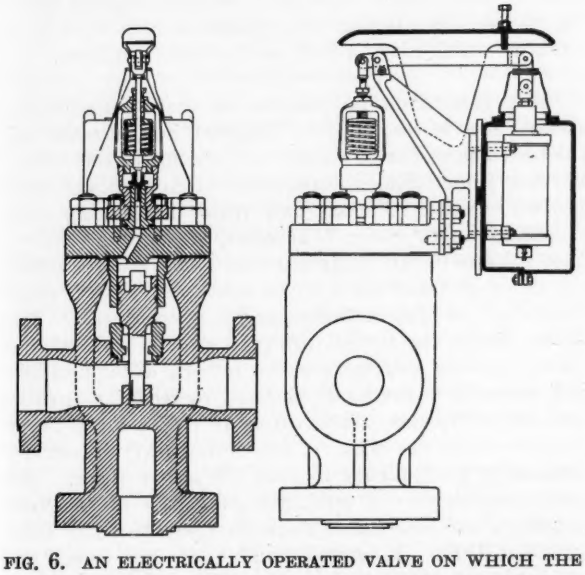


FIG. 6. AN ELECTRICALLY OPERATED VALVE ON WHICH THE BLOWDOWN CAN BE REGULATED OR CONTROLLED

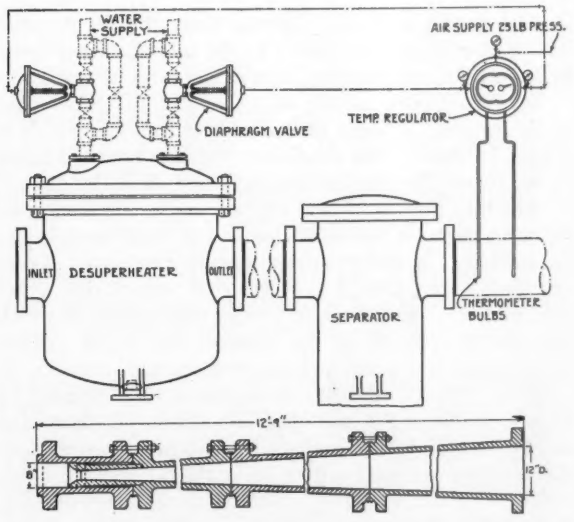


FIG. 7. EXPANSION NOZZLE AND DESUPERHEATER ARRANGEMENT, FOR USE IN THE BYPASS FROM THE HIGH TO THE LOW PRESSURE STEAM MAIN

No traps are used on the 1200-lb. pressure systems as all saturated steam piping is drained downward into the superheater and no drains are kept open on the superheated steam lines when operating. Drain lines to the exhaust system with small diameter orifices for throttling are used for starting.

In view of the importance which high pressure installations are already assuming in the power plant field of this country and abroad, it is encouraging to know that the development depends largely upon the progress that can be made with the main units and that valves, control apparatus and other auxiliary equipment can be developed to meet practically any condition that may arise.

Economical Problem of Liquefaction of Coal

By Dr. Carl Commentz

WHILE in Great Britain the coal industry has undergone considerable losses by the miners' strike, the Continental producers have strengthened their financial capacity and this fact will no doubt serve to promote some important methods of liquefaction of coal, that is of producing oil on a large scale from coal. The most important processes are in the hands of the German chemical trust, the J. G. Farbenindustrie and of the Ruhr Coal Syndicate. The process of the chemical trust, which has been devised by general director Dr. Bergius, will be applied on a commercial basis before long in some large plants that are under construction. The procedure has been made more and more economical and, according to a report given some time ago, is now in a state which promises good economical results.

The products which emanate from the plants used in the Bergin process are: 1, the oil; 2, nitrate contained in the coal, which is won in the form of ammonia; 3, unaffected parts of the coal (about 1 to 15 per cent of the original amount of coal, depending on quality); 4, gas; 5, water. The unaffected residues are used again in the plants for heating purposes and so is the gas.

The oily parts which are won must be distilled carefully by methods which are similar to those used in the oil industry in order to get market products. There are finally won from 1 t. of gas coal (containing 6 per cent of ashes) and from hydrogen and ironoxide which are also introduced in the process, 300 lb. of refined neutral gasoline with boiling temperatures between 86 and 445 deg. F., 400 lb. of oil which may be used in Diesel engines or for impregnation, 120 lb. of lubricating oil, 160 lb. of boiler fuel oil; 70 lb. of oil are lost in the refining process. Apart from the oil there are won 470 lb. of gas, 150 lb. of water, 10 lb. of ammonia, 480 lb. of coky residues, while 40 lb. are lost in the process. For heating and power generating purposes to hold up the process 800 lb. of coal are required, so that altogether 2800 lb. of coal are necessary to produce about 1000 lb. of valuable oil and some ammonia. These figures apply for coal of good average quality and show the present state. There is the probability that with later developments the amount of coal required for power and heating purposes will be decreased and this will be of deciding importance for the economy; that this is possible has been confirmed again by a new arrangement, by which the power can be partly reintroduced into the process; the saving which is made by this latest innovation is not involved in the above figures.

A plant which produces about 50,000 t. of artificial coal oil per year will cost about 8,000,000 marks, if the necessary reserve is fully regarded. Depreciation costs for the plants must be calculated with 10 per cent per annum. As coal price there can be accepted 10 marks per ton; most of the coal necessary for the process may be dust coal of which enormous quantities are available for half the price (at normal times) in many coal producing districts of Germany. One of the main factors of production costs is the price of power, which has been accepted as 0.03 marks per kilowatt-hour. This is rather high considering the fact that the power is used during 24 hr. of the day, a fact by which current prices are much reduced. The production process is such that the refining of oil is entirely embraced in it. Therefore the average price is not for a crude oil mixture but for the sum of fractions of refined oil. The average production price of the oils generated by the Bergin procedure is 90 marks per ton and it may be reduced to 78 marks if power is produced in a power plant belonging directly to the liquefaction plant. Of course, the production price may be much lower, if the normal price of dust coal is calculated. The production prices must be compared with the market prices of the products. Gasoline must be taken at 300 marks per ton, Diesel and impregnation oils at 100 marks per ton, lubricating oils at 300 marks per ton and boiler fuel oil at 85 marks. The average value with the same percentage relation marks out to 140—190 marks per ton. Thus, as a matter of fact, oil prices might go down to 40 to 65 per cent of their present values before the economy of the process is endangered.

Giving these figures, Dr. Bergius added that he is loath to publish them before his assumptions have been proven to be facts by a large plant working on a commercial basis. It is necessary, however, to make cautious precalculations before building a plant in order to fix the possibilities. Of course, much depends on the coal and there are many kinds of coal which lend themselves unfavorably for the procedure. The future of coal liquefaction is much dependent on the districts where cheap coal is produced and also the quantity of oil which may be generated in this way depends much on the available quantity of coal. But from the technical and from the economical side the liquefaction of coal is no longer a problem but an absolute possibility which will become a reality before long. It will still take, however, considerable experimenting and financial backing to build plants that can produce artificial oil in a quantity which plays a part on the world's market.

The influence of forests in the regulation of stream flow is discussed by Raphael Zon, director of the Lake States Forest Experiment Station of the Forest Service, United States Department of Agriculture, in a booklet entitled "Forests and Water in the Light of Scientific Investigation" republished by the United States Department of Agriculture. The booklet shows the effect of forest cover to be most beneficial on steep slopes and on high elevations and nonporous soils. The forest breaks the force of storms, absorbs some of the water, permits still more water to seep down into the soil where it is gradually released to feed the springs and larger streams. The maintenance of a forest cover is shown to be the cheapest and best way of preventing erosion by its tendency to bind the soil in place. The study was originally published as a part of the final report of the National Waterways Commission to Congress in 1912. A limited number of free copies are available on application to the Office of Information, Department of Agriculture, Washington, D. C.

In 3 yr., 105,000 farms have been connected to receive electrical service, an increase of 86 per cent.

Oil Field Diesel Plant Has High Load Factor

INSTALLATION MADE IN RECORD TIME SHOWS GOOD ECONOMY AND THE REPORTED OUTAGE OF 1.4 PER CENT OF THE HOURS RUN IS MADE UP LARGELY BY INSPECTION

DURING the past few years there has been a decided tendency toward electrification in the oil fields. Rapidity of construction and dependability are, perhaps, of more importance than in any other industry, particularly in fields where a considerable quantity of water is encountered. Pumping must be continuous as an hour's shutdown means several hours' water pumping before oil is again obtained. For this reason, the load on many plants does not vary five per cent from day to day.

In the fall of 1925 the North & South Oil Co. of Luling, Texas, later taken over with the rest of the Luling field by one of the larger national producers, decided to electrify. In 60 days from the time this decision was reached, the first unit was put in operation, and in 90 days five units were furnishing power to pump 300 wells located in a field ¼ mi. wide and about 8 mi. long. These five units were followed by two additional units installed about four months later.

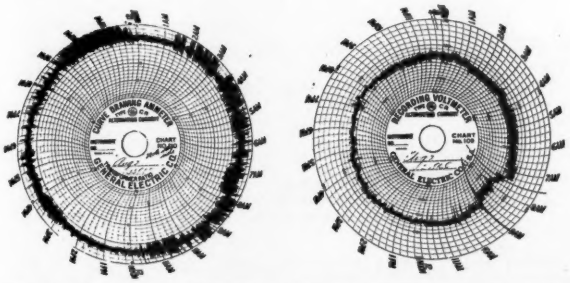


FIG. 1. TYPICAL VOLTMETER AND AMMETER CHARTS SHOWING THE CONSTANT LOAD THROUGHOUT THE DAY

The station is located in the center of the field about 7 mi. from the town of Luling, the nearest railroad station. Seven 600-hp. Worthington vertical six-cylinder, 200-r.p.m., 17 by 25-in. air injection Diesel engines, direct connected to Allis-Chalmers 500-kv.a., 110-v. generators with direct connected exciters are housed in a 60 by 126-ft. steel building covered with sheet iron. Power distribution is taken care of through a General Electric switchboard. DeLaval oil centrifuges are used for both the fuel and lubricating oil, and the circulating water pumps are motor driven.

Typical load and voltage charts are shown in Fig. 1. No voltage regulator is used, which accounts for the irregularity of the voltage. Because of the high load factor and low fuel cost, about $1.25 per barrel, the cost of producing the current has been low. Including operating expenses, maintenance, interest, depreciation and overhead, the overall cost during the period the station was operated by the North & South Oil Co. was in the neighborhood of $0.01 per kw-hr. This, of course, was with a load factor of around 85 per cent and must not be considered typical of Diesel plants which often do not have such favorable load characteristics.

Operating records over a representative period of six months, Table I, show a total of 27,953.5 engine-hours, or 13,665,600 b.hp.-hr. run and 397.5 engine-hours off. The hours off as listed include all times the engines were shut down for maintenance, repair or other work, such as pipe changes made by the manufacturer.

RECORDS SHOW 11.47 KW-HR. PER GAL. OF CRUDE OIL

All current for use around the station is taken directly from the bus bars and is not metered. It amounts to approximately 75 kw. per hr. used for circulating pump motors, lights, ventilating fan motors, fuel oil heaters, centrifuge machines, etc. Meter readings of the current put on the line during the same period of six months, are also shown in Table I, together with the lubricating and fuel oil consumed. The quantity of other miscellaneous items, such as kerosene rags and water treating compound, are also shown on the table. The fuel used is Luling Crude, running about 28 deg. Baume and the records show a production of 11.47 kw-hr. per gal. of fuel. A total of 5902.5 gal. of lubricating oil represents approximately 3842 b.hp.-hr. per gal.

TABLE I. POWER PRODUCTION AND OPERATING RECORDS SUMMARIZED BY MONTHS

Month	Eng. hr. run	Eng. hr. off	Kw-hr. produced	Lubr. oil used-gal.	Fuel-oil used-bbl.
Feb. ..	3,318	42	1,018,900	426.0	2,194
March .	4,377½	117½	1,364,200	755.5	3,197.5
April ..	4,964	76	1,589,700	1,146.5	3,232
May ...	5,131½	76½	1,724,300	1,247.0	3,388
June ..	4,991½	48½	1,648,800	803.25	3,282
July ...	5,171	37	1,684,200	1,524.25	3,444
Total ..	27,953½	397½	9,030,100	5,902.25	18,737.5

Note: Hours off 1.4 per cent of hours run.
At 42 gal. per bbl., 18,737.5 bbl. = 786,975 gal.
11.47 kw. per gal. of fuel and 2842 b.hp. = hr. per gal. of lubricating oil.

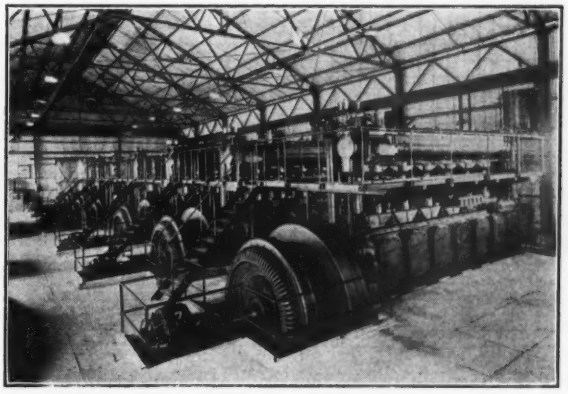


FIG. 2. VIEW TAKEN FROM ONE END OF THE BUILDING SHOWING BUILDING CONSTRUCTION AND ARRANGEMENT OF ENGINE, GENERATORS AND EXCITERS

Typical reports of work done on the engines for the

month of July taken from the plant log run as follows for the engines receiving the most and least attention:

TABLE II. A SUMMARY OF THE ITEMS IN TABLE I FOR SIX MONTHS SHOWS THE QUANTITY AND RELATIVE IMPORTANCE OF THE VARIOUS ITEMS ENTERING INTO THE PLANT OPERATION

Item	Quantity	Unit cost	Total cost
Fuel, bbl.	18,737	$1.25	$23,422
Labor	.....	.....	11,400
Lubr. oil, gal.	5,902	.75	4,426
Rags, lb.	2,853	.20	560
Distillate, gal.	760	.07	53
Water pumping, gal.	4,500	.05	225
Water compound, lb.	5,430	.25	1,357
Maintenance, mo.	.....	700.00	4,200
Total	.....	.....	$45,643

Produced 9,030,100 kw-hr. Operating cost $0.005 per kw-hr.

Engine No. 2

7/15. Changed all compressor valves—worked on lubricator.

7/29 Changed high pressure compressor valves, and put ⅜-in. water overflow pipes on cylinder head.

Total hr. off—2¾.

Total engine-hours run during month—5171.

Total engine-hours off—37.

Rigid Inspection Schedule Maintained

Plant operation and maintenance is taken care of by a crew of 11 men working on 8-hr. shifts. The plant is in charge of the chief engineer, who has one engineer and three oilers on the day shift and one engineer with two oilers on each of the night shifts. The day shift does all the regular maintenance work, which necessitates shutting down an engine, while the night shift looks after the auxiliary equipment and assists in grinding valves.

Maintenance charges are taken care of by contract on a horsepower basis over a period of years. In this connection a rigid schedule is followed and valves are changed on the dates scheduled whether or not the need is apparent. Spray and compressor valves are changed every 30 days, exhaust valves every 60 days and inlet valves are changed every 90 days. Fuel pump valves are examined periodically but required little attention.

LOG SHEET

ELECTRIC POWER STATION
UNITED NORTH & SOUTH OIL CO., INC.

LULING, TEXAS. Augusta

HOUR	ENGINE NUMBER 1	2	3	4	5	6	7	LINE METER READINGS No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
1 A.M.								6228	2584	8568	6960	Total	
2 "								6240	2604	8581	6874	4900	
3 "													
4 "								6252	2619	8592	6886	4400	
5 "													
6 "								6264	2623	8604	6899	4700	
7 "													
8 "	—							6275	2632	8616	6912	4500	
9 "													
10 "	—							6287	2642	8628	6925	4700	
11 "													
12 "								6299	2651	8639	6938	4500	
1 P.M.													
2 "								6311	2660	8651	6951	4600	
3 "													
4 "								6322	2669	8662	6964	4400	
5 "													
6 "								6333	2679	8673	6976	4400	
7 "													
8 "								6345	2688	8685	6989	4600	
9 "													
10 "								6357	2698	8697	7002	4700	
11 "													
12 "								6368	2708	8708	7016	4600	
TOTAL								1402	114	140	156	53000	

TOTAL ENGINE HOURS 1664

CAUSE FOR DELAY #1 down ½ hr. to change spray valves.

TOTAL KW. TODAY 24800

TOTAL KW. YESTERDAY 24250

TOTAL KW. PRODUCED 53000

POWER FACTOR

6 A.M.	2 P.M.	10 P.M.
.86	.89	.87

LUBRICATING OIL

KIND	GALS. REC'D	GALS. USED	ON HAND
900 Red		19	1529
Eng.		1	1522
Cyl.		23	216
		23½	

WATER

METER READING 6 A. M. TODAY

METER READING 6 A. M. YESTERDAY

GALLONS USED 22000

AVERAGE TEMP. TO ENGS. 6 A. M. 98°

AVERAGE TEMP. FROM ENGS. 6 A. M. 120°

ATMOS. TEMP 80° ENGS 6 A. M.

BAROMETER 29.8 WEATHER Clear

PUMPS USED 1-3-5

AMOUNT CHEMICALS USED 40 lbs

AMOUNT CHEMICALS ON HAND 245 lbs.

FUEL OIL RECEIVED

FUEL OIL GUAGE 6 A. M.

YESTERDAY TANK A 13'7" TANK B 11'4½"

TODAY TANK A 13'7" TANK B 9'10½"

AMOUNT USED 1'-4½" TOTAL 944 bbls.

REMARKS:
Shifting the water tank @ 12 M.
" " " @ 11:30 P.M.

REPAIR WORK 1ST SHIFT 12 M.-8 A.M.	REPAIR PARTS USED
Reamed #400 main brgs.	
" #600 " "	
Reamed ¼ HP valves	
2ND SHIFT 8 A.M.-4 P.M.	
Changed all spray valves and HP on both units	
3RD SHIFT 4 P.M.-12 M.	ENGINE ROOM SUPPLIES REC'D
Grinding valves #1 eng.	12 abs. Ite emery cloth. 1 pt. Linseed oil 1 can 4/18 Lbs. H.C. Rags.
EXTRA LABOR	REPAIRS ORDERED

ELECTRICIAN W. E. Matthews
1ST ENG. J. A. Clark
2ND ENG. E. P. Shaw
3RD ENG. C. H. Foster
CHIEF ENG. A. D. Lingo

FIG. 3. A COMPLETE RECORD OF PLANT OPERATION IS KEPT EACH DAY ON A LARGE LOG SHEET FILLED IN BY THE ENGINEER

7/21. Changed all spray valves, high pressure compressor valves, No. 4 exhaust valves and put on one new exciter brush.

7/25. Pulled No. 2 piston. Wristpin bearing loose due to poor adjustment.

7/28. Put ⅜-in. water overflow pipes on cylinder head.

Total hr. off—13.

Engine No. 4

7/3. Changed all spray valves and high pressure compressor valves.

7/12. Replaced broken feather valve in low pressure compressor.

DUKE POWER CO., Charlotte, N. C., has preliminary plans for a number of projects to be carried out during the coming year. The company plans to build three steam generating plants, a hydro-electric plant at Oxford Shoals in North Carolina and another hydro-electric plant on a site not yet announced. Work is now under way on a hydro-electric development at High Rock near Salisbury, N. C., for the Tallahassee Power Co.

PROF. L. K. RAMZIN, director of the Thermotechnical Institute of Moscow and his assistant, A. I. Moroz, are visiting the United States to make a study of American power stations.

ELECTRICAL MACHINERY FOR LIGHT AND POWER

Power Line Carrier Current Communication

VOICE MODULATED HIGH FREQUENCY CURRENTS SUPERIMPOSED ON POWER CURRENT PROVIDE A RELIABLE MEANS OF COMMUNICATION AT ALL TIMES. BY C. A. BODDIE*

IN THE OPERATION of large power systems, reliable telephone communication is a matter of great importance. In the case of companies operating city systems, leased telephone circuits from the telephone companies have proved satisfactory, but where the power companies operate long lines such lines do not provide the reliability demanded. In such cases power companies have built their own lines paralleling the transmission lines, but because of induction from the power line and the relatively light construction of the telephone line compared to the power line, even these privately-owned lines have not been satisfactory.

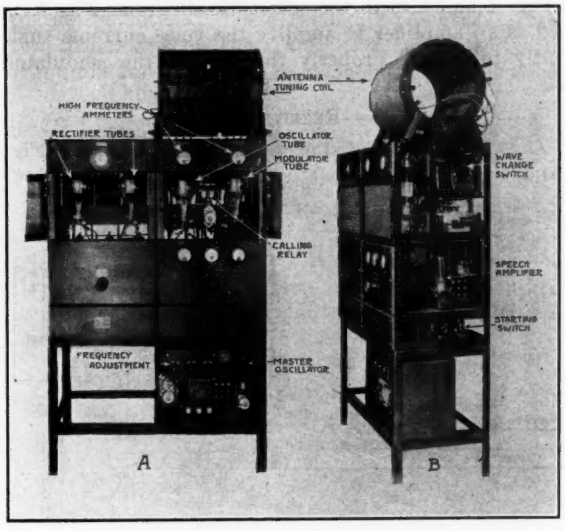


FIG. 1. TWO VIEWS OF A 250-WATT TRANSMITTER

To overcome the troubles inherent to a wire telephone line, telephone communication is now being effected over the power wires themselves by means of high frequency currents. These high frequency currents transmit the telephone voice currents by variation in their intensity, in very much the same way as variation in intensity of direct current transmits voice currents in an ordinary wire telephone system. The same conductors which are used for transmitting power are used to transmit the high frequency telephone currents, thus saving the cost of a separate telephone line. Aside from the saving in cost, the principal advantage gained is that the mechanical strength of the telephone circuit is equal to that of the power line, since the power conductors are in fact the telephone line. A further advantage is that interference due to induction from the power line is practically eliminated. It is therefore much less liable to interruption. With such a system the line can come down and even break without interrupting communication, provided a single conductor, even though lying on the ground, is unbroken.

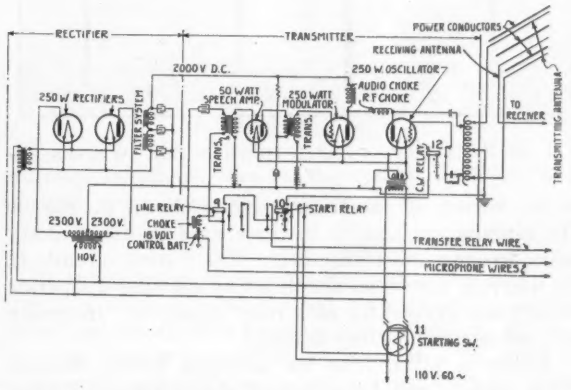


FIG. 2. WIRING DIAGRAM OF THE 250-WATT TRANSMITTER

Frequencies used for this class of communication are of the order of 50,000 cycles. These are generated by vacuum tube oscillators in the same way that radio frequencies for broadcasting are generated, and are induced in the power line in one of two ways; first by coupling wires or antenna supported on the same towers as the power line and paralleling the power conductors for 1500 to 2000 ft. and second by condensers coupling the apparatus directly to the high voltage power line. Either method of coupling may be used, depending upon the circumstances and individual preferences. The electrical efficiency of both methods is quite high. The coupling wires are usually the cheaper for high voltage lines.

The high frequency currents induced in the power line by the transmitter are superimposed on the power currents and flow along the line just as though the power currents were not there. At receiving points these currents are picked off the power line by coupling

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wires or coupling condensers tuned to the frequencies to be received. The receiver itself is similar to that used for radio reception.

The Transmitter

Figures 1 and 2 show a typical transmitter for generating the high frequency currents used in talking over high voltage power lines. This transmitter is rated at 250 w.; that is, it has a high frequency output of 250 w. The transmitter consists of two parts, a rectifier shown in the left-hand section and the transmitter proper shown in the right-hand section. A schematic diagram

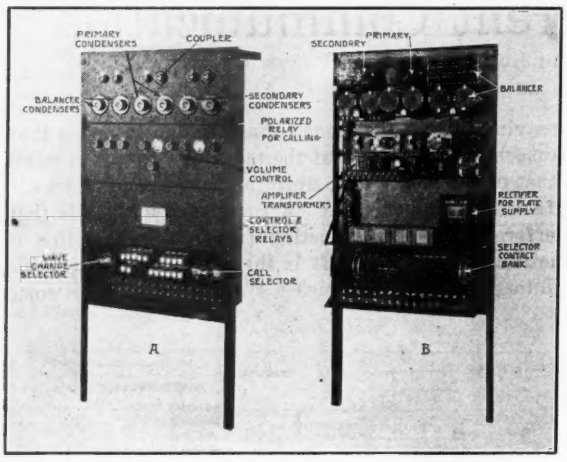


FIG. 3. FRONT AND REAR VIEWS OF THE RECEIVER

of the wiring of the transmitter is shown in Fig. 2. The circuits are similar to those used in an ordinary radio broadcasting transmitter. The control circuits in the diagram have been simplified by showing a separate battery and ground for each relay employed. In reality only one control battery is used.

Power is taken from an ordinary 110-v., 60-cycle power circuit, and by means of a step-up transformer is applied to the plates of the rectifier tubes shown in the left-hand section, Fig. 1, which rectify the 60-cycle alternating current and provide 2000-v. direct current as a source of power to supply the transmitter.

The right-hand section of Fig. 1 is the transmitter proper. It contains two 250-w., three-electrode vacuum tubes. The left-hand tube generates the high frequency currents which are fed into the tuning coil just over the transmitter. This coil is used to tune the coupling wires to the frequency which is to be transmitted. The frequency is determined by the number of turns of this coil which are used, and by the capacity of the coupling wires. The right-hand tube is the modulator tube. Voice currents from the operator's microphone are impressed on the grid of this tube, which varies the output of the oscillator tube in accordance with the requirements of the voice.

The way in which modulation is accomplished may be seen by referring to the diagram, Fig. 2. The oscillator and modulator are connected in parallel and fed through a large choke coil, which has so much inductance that it maintains the current supplied to both tubes substantially constant. When the voice currents are applied to the grid of the modulator, the current through this tube varies from instant to instant. If the grid is thrown positive with respect to the filament, the modulator tube draws an increased current from the common junction of the modulator and oscillator. This robs the oscillator tube of current, since the choke coil compels a constant total current to flow to both tubes. The oscillator tube therefore runs at a reduced amplitude, that is, the output into the power line is reduced when the grid of the modulator is positive. Similarly when the modulator grid is negative, the current through the tube is reduced, thus making available an increased supply of current for the oscillator, which accordingly feeds an increased high frequency current into the power line. The voice currents applied to the modulator grid therefore cause the intensity or amplitude of the high frequency current to rise and fall in exact accordance with the rise and fall of the voice currents.

Speech Amplifier

Voice currents coming from the microphone of the operator's desk set are not strong enough to control the grid of the large modulator tube, so a 50-w. tube, shown in Fig. 1 and also in the schematic diagram, Fig. 2, is used as an amplifier to amplify the voice currents sufficiently to control properly the grid of the modulator tube.

Receiver

A general view of the receiver is shown in Fig. 3 and Fig. 4 is a schematic diagram of the principal

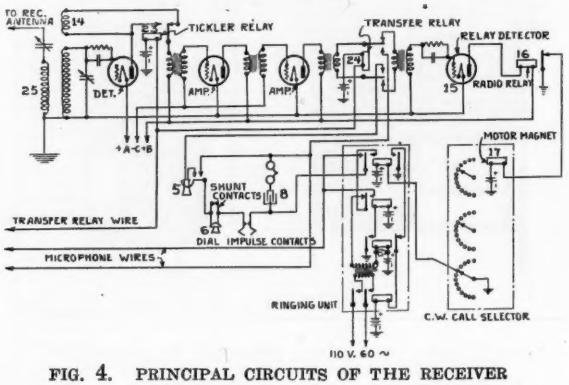


FIG. 4. PRINCIPAL CIRCUITS OF THE RECEIVER

circuits in the receiver. The receiver is of the coupled circuit type, that is, it has two tuned circuits each tuned to the frequency to be received. One of these circuits, the primary, tunes the receiving antenna or coupling wire. The other tuned circuit or secondary receives its energy by induction from the primary in a small coupling coil, which loosely couples the two circuits. The output of the secondary is applied to the grid of the detector tube, which rectifies the incoming modulated high frequency current, and delivers an audio or voice current to the amplifier. The output of the amplifier is delivered to the desk telephone receiver through relay 24, Fig. 4.

The receiver is assembled in four sections or panels. The top panel carries all the high frequency apparatus, that is, the primary and secondary inductances, tuning condensers and balancing equipment. The second panel carries all vacuum tubes, amplifying transformers and other accessories necessary to the detection and amplifi-

cation of the signal. The third panel carries a rectifier which supplies plate current to the plate circuit of the receiver. It also carries a B battery which floats across the plate rectifier. The purpose of this B battery is not to supply energy, but to stabilize the plate potential in case the line voltage supplying the plate rectifier varies. The fourth or bottom panel carries all control relays and selective equipment, which go to make up the automatic features of the telephone system. An ample terminal board is provided so as to permit the wiring to be neatly installed.

Balancer

It will readily be appreciated that the receiver at each station is exposed to the direct influence of the full power of its own transmitter. The receiver, of course, is tuned to a different frequency than the transmitter, and this prevents the transmitter feeding energy into the receiver to some extent. Simple tuning, however, is not sufficient. In order to protect the receiver against its own transmitter the method here adopted is to balance out the induced potential by applying equal and opposite potentials. These balancing potentials are derived from taps on the transmitter tuning coil. The magnitude and phase of the balancing potential is controlled by a condenser and resistor shown at the upper left-hand corner of Fig. 3. By this means a perfect balance is obtained, thus leaving the receiver free to respond to the signal of a distant transmitter.

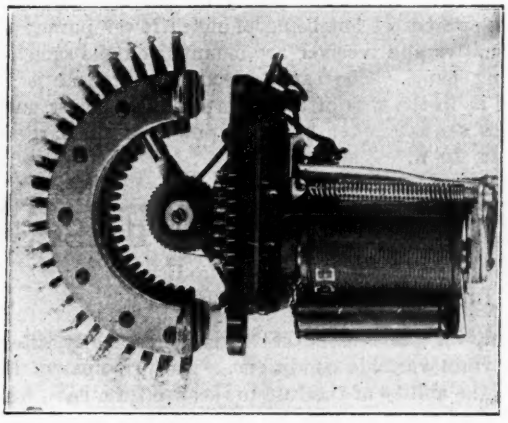


FIG. 5. SELECTOR MOTOR MAGNET AND CONTACT BANK

Operation

This system is entirely automatic, a desk telephone set controlling all operations. When the receiver is lifted from the hook, the transmitter starts and high frequency energy is fed into the power line by electrostatic induction from the two antenna wires associated with the power line. These coupling wires are at opposite potentials at all times, and induce currents of opposite polarity in the power conductors nearest the inducing coupling wires. These currents travel along the power line just like ordinary power currents and are superimposed on the high voltage power currents. They are picked off at the distant end by the coupling wires and receiver described above.

When the calling dial on the desk telephone stand is operated, impulses of high frequency current corresponding to the number pulled on the calling dial, are sent into the line. These impulses are received by the distant receiver, and are used to advance the arm of a selector, Fig. 5. If the number dialed corresponds to the number on which the selector arm stops, the call bell rings and the distant operator answers.

When the distant operator unhooks, his transmitter starts and sends out high frequency currents which are received at the calling station. This frequency is different from the first frequency, that is, one frequency is used by the calling station to transmit and another frequency is used to receive. These frequencies may be 50,000 cycles and 60,000 cycles. By using two such frequencies the two parties at the ends of the line may talk and listen with the same freedom as is customary on an ordinary telephone, that is, the system gives two-way communication commonly called duplex.

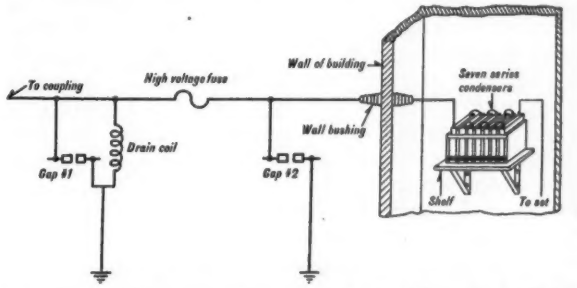


FIG. 6. PROTECTIVE APPARATUS DEVELOPED TO GUARD AGAINST HIGH POTENTIALS DUE TO LIGHTNING OR CONTACT WITH POWER WIRES

Heterodyne Calling

It is important that the calling system be very reliable and efficient. The method adopted in the equipment here described is known as the heterodyne system. It is the same as that which has been used for years in commercial radio telegraphy and is based upon the principle of combining the incoming high frequency signal with a locally generated frequency. These two currents of different frequencies assist and oppose each other at a frequency which is equal to the difference of the two main frequencies. This derived frequency is called a beat frequency.

When the receiver is in a condition to be called, the beat frequency is amplified and fed into two detector tubes connected in parallel, one of which is shown schematically at 15, Fig. 4. The negative charge built up on the grid condenser biases the grid strongly negative when a signal is received. This reduces the plate current of the detector tube almost to zero and releases the armature of a polarized relay 16 connected in series with the plate.

The contacts of this polarized relay advanced the motor magnet of this selector one notch. At each interruption of the high frequency current from the calling station, the motor magnet of the selector advances one step. If the selector pauses on a contact corresponding to the station being called, a slow relay drops out and closes contacts which rings the call bell.

The contacts of the polarized relay control the movement of the selector. The selector is of a type commonly used in automatic telephone systems. Its principal ele-

ment is shown in Fig. 5. It has a contact arm which is driven over a bank of contacts by an electro-magnet through a ratchet and pawl. This driving electro-magnet is called the motor magnet. At each interruption of the high frequency current from the calling station, the contacts of the polarized relay advance the motor magnet of the selector one step. By a combination of fast and slow relays the arm of the selector is made to move over its bank of contacts without closing a circuit, until it finally pauses on the contact corresponding to the number dialed.

Protective Equipment

The protective equipment has been very carefully worked out. It is designed to protect the apparatus and personnel from any high voltage such as that induced by lightning or by direct contact between the coupling wires and the power line. The circuit arrangement is shown in Fig. 6. Two heavy spark gaps are separated by the high voltage fuse. No. 1 spark gap is set with a little greater gap than No. 2 spark gap, which is connected to the apparatus side of the high voltage fuse. In case of contact between an antenna wire and a power conductor, No. 2 gap will flash over and the entire current will pass through the high voltage fuse. It is not intended to attempt to open the circuit with this protective equipment, but merely to divert the current to ground and isolate the communication apparatus from the power system. The high voltage fuse, in trying to clear the circuit, will raise the potential, and flash over No. 1 spark gap and conduct the main current rush to ground. This allows the high voltage fuse to open and separate the power system from the communication equipment. In order still further to protect against the possibility of power voltages being impressed on communication apparatus, a protective condenser, able to withstand 20,000 v., is connected in each lead going to the set. A drainage coil mounted in a small transformer case is used to drain off the 60-cycle charging current induced in the antenna wires by the high voltage power conductors.

The equipment described in the foregoing has provision for generating a large amount of communication energy. The reason for making the set so powerful is that experience has shown it to be necessary for this class of service. Most power lines today are not simple lines between two points, such as telephone line usually is, but is part of an extensive network or system. The amount of energy required increases with the number of branches, and changes sometimes seriously every time a high tension switch is opened or closed. In order to make provision for these varying circuit conditions, to insure reliable service in bad weather and in view of the very great importance of the service rendered, a liberal amount of power has been provided in this design.

For low voltage lines or for short distances on high voltage lines, a small set which is self-contained has been developed. It has nearly all the features of the high powered set but being of much lower power, both transmitter and receiver are mounted on the same supporting panel. The same selective equipment is provided as in the case of the large set. The power output of this set is one-tenth of the power of the large set, that is, 25 w.

Interesting Facts Regarding Electrical Fuses*

Materials and Thermal Characteristics, Size and Form, Nature and Use of Fillers, Functioning of the Fuse and Indicators. By G. R. Brown†

ELECTRICAL FUSES are designed to protect circuits and connected apparatus from the disastrous effects of excessive current. In their earliest forms fuses consisted merely of short lengths of copper wire of smaller cross section than the conductor used in the circuit. Copper, however, failed to give the desired protection because it permitted excessive heating in the remainder of the circuit before fusion occurred, so materials of lower melting points than copper were tried, principally lead or lead alloys. The solution was not as simple as it might appear, however, and the evolution of the modern fuse has demanded consideration of many factors and much experimentation has been necessary to produce the simple and effective type of fuse now in use on low voltage circuits.

As is well known, the principle involved in all fuses is that a short length of metal may be raised to its melting point if a sufficiently high current is made to pass through it. Under ordinary conditions, it may be said that for a given cross-section and length of this metal there will be a definite temperature rise for a certain current strength. In practice, however, the temperature rise in a fuse does not bear that definite relationship to the current that might at first be expected, for the reason that it is very greatly affected by certain variable conditions. The principal of these are: the ability of the fuse to throw off the heat, which, so far as the fuse link or wire itself is concerned, is largely governed by its superficial dimensions; the position of the fuse links; the condition of the surrounding atmosphere, as to whether it is in motion or quiet, which is a still more uncertain factor than either of those before mentioned; and whether the fuse link itself is in contact with any body whose ability to absorb the heat developed is greater than that of air. It will be seen that a condition may exist wherein the rate of radiation or loss of heat by the fuse equals the rate at which the heat is developed. There will then exist a state of equilibrium and, should the temperature be just below that at which the metal softens, the fuse will be carrying its maximum current.

Heat Radiation Characteristics

If the current should now be increased slightly, the rate of development of the heat becomes more rapid than the rate of dissipation, with the result that the temperature increases gradually; and in time the melting point will be reached. This increase in the current value will constitute an overload since it is in excess of the maximum current that the fuse will carry. With a further increase in current the balance

*Abstracted from an article in the General Electric Review.
†Wiring Supplies Division, Engineering Dept., Bridgeport Works, General Electric Co.

is further disturbed, the rate of radiation remaining practically the same while the rate of development of heat is more rapid than before, with the result that the time required to bring the mass to the melting point is considerably less; or, in other words, the time factor for any given overload becomes rapidly less as the current increases, the time factor being the time required to bring the fuse to its melting point from the moment of the increase of current above the normal current-carrying capacity of the fuse. The two most important of the variable factors which affect the rate of radiation of the fuse are probably the exposure to draft and contact with adjacent bodies. In a draft the heat is more rapidly taken up by the passing air than if it were quiet, while by contact with a body of such material as porcelain or metal, whose rate of absorption of heat is greater than that of air, an equilibrium may be established and maintained until the body becomes heated. Under such conditions it will be found that a fuse will require a much longer time to reach the melting point.

Nature of Fuse Terminals Affects Time of Fusion

Another feature of uncertainty, of much the same nature, is the effect of the fuse terminals in establishing this time factor. If the fuse metal is connected to very massive terminals with large thermal capacity, the time factor will be materially increased. If, however, the terminals are small and light so that they possess but comparatively small heat-conducting ability, they can have little effect in changing it. To correct these defects, then, it becomes necessary to fix all the otherwise variable factors in order to secure a device the melting point of which for any given overload is practically constant.

It has been found, however, that in fuses above certain sizes, particularly those adapted to carrying heavy currents, trouble is frequently incurred when the fuses are subjected to a severe overcharge of current. This is due to the fact that the volume of metal volatilized by the action of the current and requiring dissipation is so great that there is likely to be a severe explosion when the sudden expansion of the comparatively large volume of metallic vapor occurs. Several ways have been tried in seeking to overcome this difficulty, among them being the use of an alloy of high conductivity, by which means the cross-section of the link would be materially reduced; but it has been found that all alloys of high conductivity, such as alloys of tin, copper, and the like, whatever the bulk of the metal, vaporize with what may be called explosive action. On the other hand, metals of less conductivity, such as lead, cadmium or bismuth, form eutectic alloys which, within certain limits as to bulk, can be transformed from metal to vapor almost instantly, and without undue disturbance; but in fuses of large capacity a single fuse link of lead or lead alloy must necessarily be of large cross-sectional area and of considerable bulk, and is therefore apt to vaporize with an explosive action for the reasons mentioned.

Fuse metals of high conductivity, too, have a comparatively high melting point; and if the circuit becomes loaded to the full capacity of the fuse, the enclosing case must either dissipate this high temperature or become excessively hot. So the middle ground is taken as conforming to the best practice, and zinc or zinc alloys are used almost universally for the fusible element in enclosed fuses. Even with pure zinc, the pressures exerted inside the fibre casings, under short-circuit conditions, sometimes measure as high as 250 lb. per sq. in.

There are many grades of commercial zinc and as many differing results dependent upon their use in enclosed fuses. The melting away of the pure zinc from a fuse strip may leave a network or bridge of impurities having a still higher melting point and capable of carrying current of considerable volume. Therefore, pure zinc, or zinc alloyed with lead and cadmium only, gives a more dependable performance. The element must also be annealed, after rolling, to remove strain hardness. Fuse strips or links of dead soft zinc will withstand the greatest amount of alternate heating and cooling, expanding and contracting, with the least signs of distress due to crystallization. The failure of a fuse while carrying less than its rated load may often be attributed to hard fuse metal.

It is found in practice that the link oxidizes when the current slowly increases beyond the maximum carrying capacity of the fuse; and if a critical temperature just below its melting point be maintained for any considerable time, a coating or skin of oxide may become thick enough to support the metal within it, even when the latter has become melted. Thus when a filling of too finely divided arc-suppressing material lies against this oxide-coated link it serves to support the skin and prevent the rupture which should otherwise occur.

Fillers

Filler is a non-conducting material, chemically inert, preferably in small pellet form (such as slaked lime or plaster of paris) providing a multitude of minute paths or interstices for the escape of the vapor or gas evolved upon the blowing of the fuse links by an excessive current. Another important function of the filling material is to dissipate the heat from the surface of the link by conduction. If the water content of the filler is too great, the effect is to increase the rate of conduction and also the carrying capacity of the fuse.

To detect the cessation of usefulness of the fuse in a convenient manner, indicators of many types have been developed. One of the most successful types consists of a high resistance wire connected in parallel with the fuse element, and having a small portion of its length brought outside the casing at a point covered by the label. A groove made in the fibre tube provides protection from mechanical injury and permits the application of the indicator paste or compound over the wire without interfering with smooth labelling. Current of normal strength passes through the fuse without affecting the indicator wire, the larger portion of the current being, of course, carried by the fuse link, because of the high resistance of the small wire. Upon the disruption of the fuse link, the voltage across the fuse terminals is raised and sufficient current passes through the indicator wire to melt it and to fire the indicator compound. This causes a blackened or charred spot to appear on the label, showing clearly that the fuse has blown.

Considered even so briefly, the matter of fuse design will be seen to embody far more labor and ingenuity than the extreme simplicity of the device might seem to demand; but, in another sense, the care and cost of the development are abundantly recompensed.

Welding of Steel Plate Work†

TYPICAL EXAMPLES OF WELDED STEEL PLATE ILLUSTRATE PRINCIPLES AND METHODS INVOLVED. BY LOUIS J. SFORZINI*

PLATE WORK IS, perhaps, the largest and at the same time the most diverse field to which welding may be and is being applied. Welding in plate work is not only encroaching on other methods for fabricating plate work but, in some instances, is even causing welded plate work to be substituted for such work as castings. Some of the common uses to which plates are applied are as tanks, pressure vessels and all types of containers; tubes and piping; hoppers, chutes and bins; air and other gas ducts; smoke flues, breechings and stacks and so on.

There are six general processes by which plates may be fabricated into desired articles; these are: cold drawing and working; hot working and forging; brazing; riveting; fire welding and fusion welding. Of these

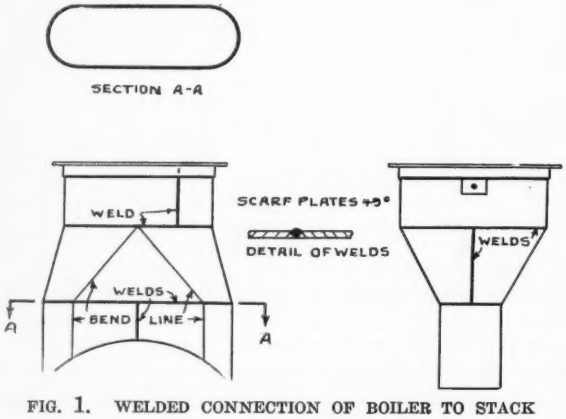


FIG. 1. WELDED CONNECTION OF BOILER TO STACK

only two, riveting and fusion welding, may be employed for nearly all classes of work mentioned above.

TYPICAL PLATE WELDING JOBS

Figure 1 depicts a connection piece between a horizontal return tubular boiler and stack. This job can be made welded or riveted easily, it was made welded because it was simpler to do so with the facilities available. All the plate welds are single V-scarfed. In this particular case templates for the lower two pieces were made full size on paper. The right angles and bearing plates were also welded.

Figure 2 is more complicated. The steel hopper is used for fine ash and was made up entirely welded. Note the simplicity of the dimensioned detail for welded work. Everything is figured for the shop; the angle lengths are all specified; the plate overall sizes are specified, and complete dimensions are given. All that is necessary for the layout man to do is to lay out the plates to the dimensions and bevels given.

In Fig. 3 is illustrated an example of work of circular cross section. This is used as an air duct. The straight sections with longitudinal butt welds are simple, as are the ring angles. The pieces for the elbow were all laid out in the drafting room by simple computation, so that all that is necessary to do in the shop is to lay out the co-ordinates to the dimensions given. Note that there is no waste of material. If the cutting is done by a torch, sufficient cutting allowance must be made. After cutting, the plates are rolled to a circular form and the longitudinal seams butt welded; the pieces are then tacked together and the circumferential welds completed.

WELDING A ROOF TANK

An unusual field job is illustrated in Fig. 4. It was desired to construct a tank 22 ft. wide by 44 ft. long and 12 in. high to act as a water pan on the roof of a building. The tank was to be attached to another existing pan, as shown in Section BB. The shop doing the work was not equipped for shearing large plates accurately, or for bending large plates. It was, therefore, decided to purchase all plates to size direct from the mill instead of using commercial size from stock. The limits specified were plus or minus ¼ in. from size. Corner angles were substituted instead of bending the plates, which is usual in plate shops. Note that there are four plates 22 ft. by 44 ft. and 110 linear ft. of plate 11½ in. wide. The only shop work performed on the four large plates was to scarf the plates with an air chisel. The top stiffener angle and the bottom corner angle were welded to the side plates to give convenient lengths for handling. The sump was also shop welded. Note the method of attaching the pipe to the sump with welding. This pan sat on a framework of metal I-beams high in the air and was to be bolted to the I's with bolts made water-tight with lead washers. The welding was done with the outside temperature averaging below freezing and with a high wind most of the time. While the welders were more or less protected from the wind by tarpaulins, the work, nevertheless, was done under adverse conditions.

This job ran into considerably more trouble than anticipated. Part of the trouble was undoubtedly caused by the unfavorable weather conditions; the balance was due to not being able to adapt the ordinary shop methods and fixtures to this job. In spite of this the cost was under that of a substitute riveted job.

Another pan, practically a duplicate, as far as dimensions are concerned, was later welded under summer weather conditions. Profiting by experience with the first pan, it was decided to substitute lap welds in place of butt welds for the bottom plates, using a continuous fillet on the inside of the pan, and stitches on the outside, the plate lapping 2 in. The pan was assembled complete with tack welds before making the final welds.

Figure 5 depicts another field job. The plan shows that this is made up of a main part 11 ft. by about 54 ft. and two 14 by 15-ft. branches. This is a plenum chamber in a stoker installation. Head room was at a premium and for this reason the chamber was made up of a combination of concrete and a shallow steel box. This required that part of the welding be done in close quarters with a head room of only 24 in. As shown in section B-B and detail, bolts were provided at a spacing

*Engineering and Maintenance Dept., Eastman Kodak Co.
†Abstract of paper presented before American Welding Society, Detroit, Sept. 22.

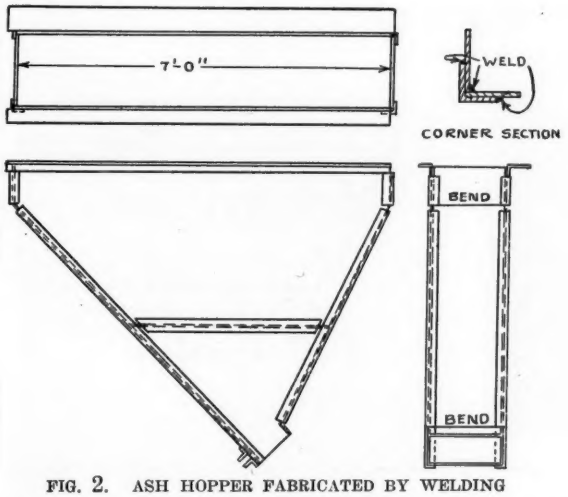


FIG. 2. ASH HOPPER FABRICATED BY WELDING

of 12 in. in the concrete beam to take a 5 by 3½-in. angle to support one side of the bottom plate. A steel side, built in the shop with welded top and bottom angles in convenient length panels was hung from bolts on inserts, also at a spacing of 12 in. to take the other side of the bottom plate. Both angles bolting against the concrete were backed up with sheet packing to make the joint air-tight. The 72-in. plates were set on the two bottom angles. The cross stiffener angles were then suspended with rods from inserts also placed in the upper slab, and the plates were tacked to the stiffeners. Everything was then welded which, of course, involved both overhead welding and welding from a laying position. Considerable warping of plates and tares in welds took place but with the use of a few bolts the plates were pulled back into place and the welds completed. Manholes were made by cutting holes with the cutting torch, and then drilling a series of holes around these openings into which bolts were inserted and welded to take the manhole covers.

There was a considerable number of concrete projections, some of which are shown in the photo, but not clearly, around which the duct had to be built and made air-tight. This was all taken care of in the field with the use of angles, plates and a few expansion bolts. The completed job was substantially air-tight and much cheaper than a substitute riveted job. The chief difficulty encountered was not in the actual welding, but in rectifying errors or, rather, inaccuracies in the bolt and insert spacing in the concrete. These were set to specified dimensions, and the angles were punched to the same dimensions, and were in fact even slotted, but in spite of this fully 90 per cent of the angle holes did not register and considerable field fitting had to be done. To avoid this difficulty, all similar jobs are now being done by providing a steel bar spacer, laid out simultaneously with the angles, to act as a bolt spacer in the concrete form.

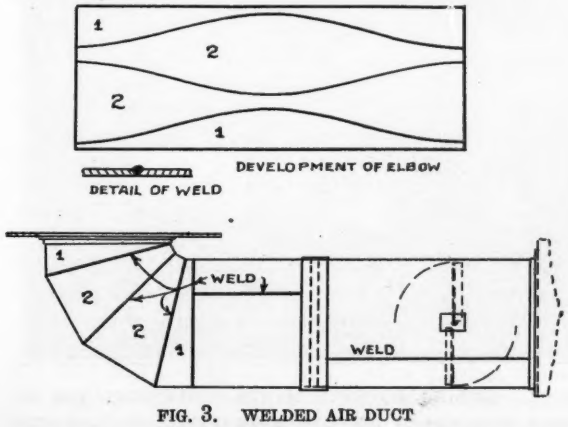


FIG. 3. WELDED AIR DUCT

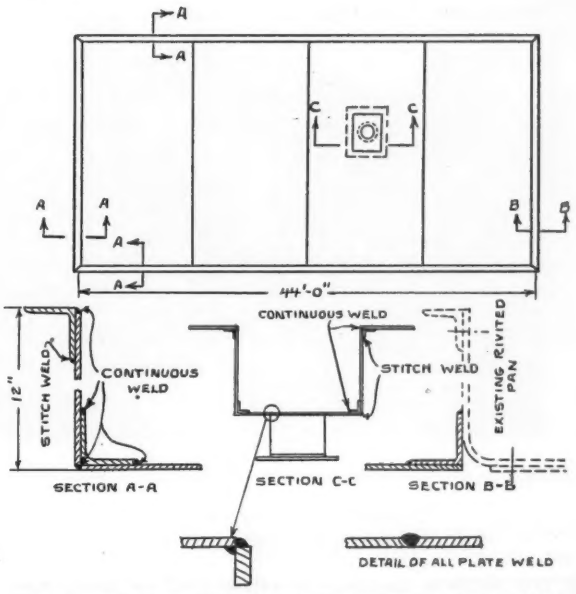
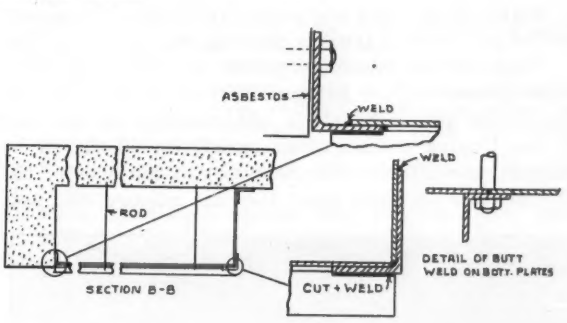


FIG. 4. WELDED ROOF TANK ERECTED IN THE FIELD



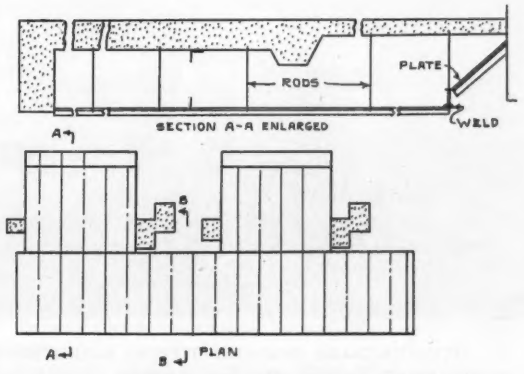
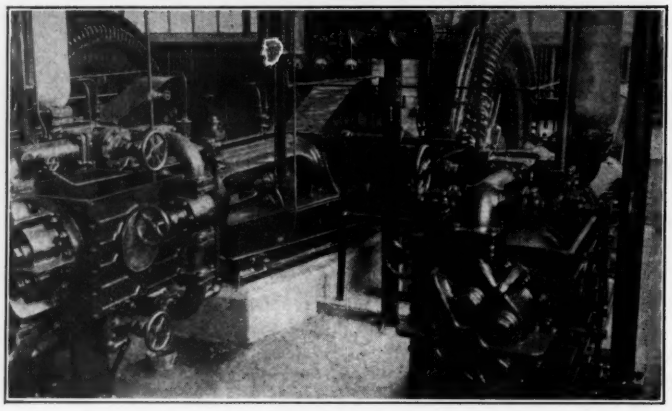


FIG. 5. WELDED STOKER AIR CHAMBER



Ice Handling Methods at National Ice Plant

RAPIDITY AND DIRECTNESS OF HANDLING AND EFFICIENT UTILIZATION OF STORAGE SPACE ARE FEATURES OF THE CINCINNATI PLANT OF THE NATIONAL ICE AND FUEL CO.

EFFORTS to increase the capacity of ice plants have recently been more in the direction of increasing the flow of the product than in size of plant. With any given plant the former is possible, while the latter, if not impossible, is so costly that selection of the method to pursue in any particular case appears to favor at least giving first thought to increasing the flow of the product. The plant of the National Ice & Fuel Co. exemplifies efficient methods of operation and shows how well increased capacity may be obtained in even smaller sized plants.

CONSECUTIVE MOVEMENT OF SIMULTANEOUSLY DUMPED BLOCKS

Eight 300-lb. cans are pulled at a time. These are carried and lowered into the thawing tank shown in Fig. 1. They are then raised and placed on the tipping table, which is operated by hydraulic pressure, and dumped. The blocks slide out onto a belt conveyor in the rear of the tipping device which causes the blocks to be brought, one after another, opposite to the door of the storage room at which point they are released and pass down a chute and through the door which is opened by the block and closed as soon as it has passed through.

In the meantime, the cans, after being dumped, are returned to a vertical position and automatically filled with a proper quantity of water from the tank which is above and in back of them, through the pipes shown in Fig. 1. The filled cans are then returned to the freezing tank.

Passing through the chute door, the ice cakes are at once served to the scoring machine shown in Fig. 2. This marks the cake in four equal parts across each side and in a center line along the length of the cake. This provides a convenient means for cutting the cake into eight equal parts or into any multiple of those parts. The snow ice coming from the scoring machine drops clear of the machine into a pit below, whence it is conveyed to a pre-cooler, which cools the filling water fed to the cans. The scoring machine is provided with rust-proof material in all essential parts which are exposed to the weather and also with a safety clutch. Blocks of varying dimensions are accommodated and accurately scored; a special device provides for the

FIG. 1. HYDRAULICALLY OPERATED TIPPING DEVICE SHOWING HOW CAKES, SIMULTANEOUSLY DUMPED, ARE PASSED CONSECUTIVELY INTO STORAGE

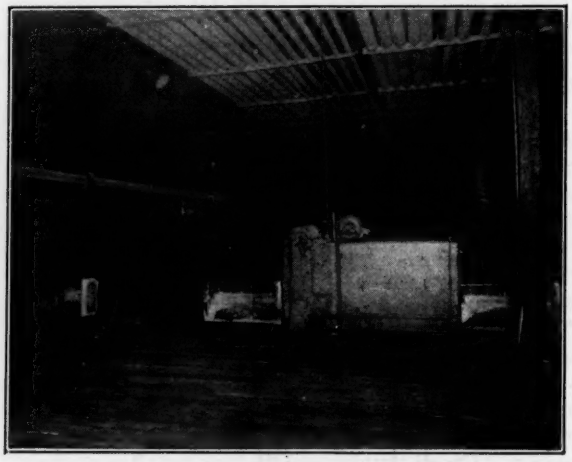


FIG. 2. SCORING MACHINE MAKES CONVENIENT THE DIVISION OF CAKES OF ICE INTO MARKETABLE SMALLER SIZES

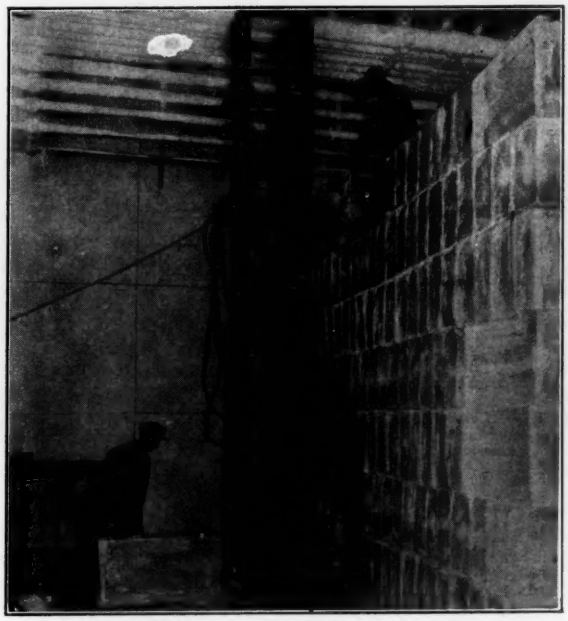


FIG. 3. ICE STACKING MACHINE MAKES POSSIBLE EFFICIENT USE OF STORAGE SPACE

scoring of the tapered ice cake. Scoring is done at a rate of from 6 to 6½ blocks per minute.

Stacking Machine Provides Efficient Use of Space

After scoring the cakes pass on to the stacking machine shown in Fig. 3, which enables them to be placed eight high in the storage room with the least amount of handling and without damage. In this way the storage space may be most efficiently used and 12,000 blocks stored. If the blocks are placed on end without stacking, as is frequently done, this same space would provide room for only 3200 blocks.

Two sets of twin ammonia compressors, each set having an ice-making capacity of 80 t., and driven by flywheel synchronous motors, are provided. Duplicate sets of the other vital machinery are also installed in order to provide for reliability of operation.

Spray Pond Provides Efficient Cooling Means

Condenser water is cooled by passing through 40 spray nozzles which are arranged in groups of five in the spray pond, which is located on the roof of the building as shown in Fig. 4. A louvre construction around the sides provides against blowing the spray from the pond.

Water which has been cooled in the pond, coming down by gravity, passes over the ammonia condensers which are of vertical tubular construction. Control of the water circulation is by means of a water reservoir located at the top. A circular baffle or ring in the top head aids in distributing the water evenly and quietly around the saw tooth ferrules that are inserted in each tube. The ammonia gas enters the shell about midway between the tube heads and occupies the space within the shell and around the tubes. After passing through the condenser, the water drops to a steel tank 6 ft. by 8 ft. by 6 ft., located underground. Centrifugal pumps

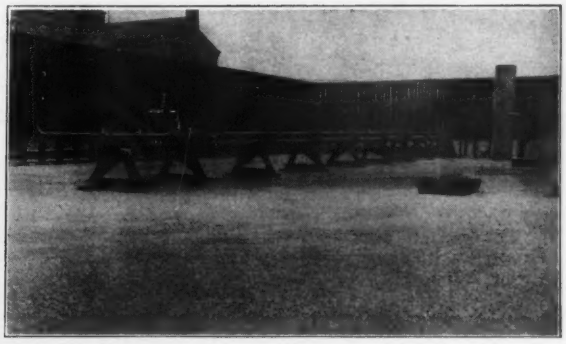


FIG. 4. SPRAY POND ON ROOF PROVIDES EXCELLENT COOLING MEANS

located on street level return the water to the spray pond.

City water is used for the ice, which is manufactured under the air-agitated raw water system, 30 lb. air pressure being used for agitation. The ice crane is electrically operated throughout.

Principal Equipment of the National Ice & Fuel Co.

2 Twin Giant Compressors—Ball Ice Machine Co.
Horizontal, double acting, 120-r.p.m., water-cooled jackets.
Normal discharge pressure—185 lb.
Normal suction pressure—24 lb.
Capacity in tons, ice-making, each machine—80.
Diameter cylinder—10 in.; 24-in. stroke.

2 Motors for ice machine drives—General Electric synchronous flywheel type, 200-hp., 120-r.p.m., 60-cycle, 440-v., 160-kv.a., 1.0-p.f.
Temperature rise, continuous run—50 deg. C.

2 Air compressors—Pennsylvania Pump & Compressor Co.
Class 3A, air cylinder, 14-in. diameter, 9-in. stroke.
Air pressure—300 lb.

2 Motors for air compressor drive—General Electric induction, 3-phase, 60-cycle, 440-v., 50-hp.
Temperature rise, continuous run—40 deg. C.

2 General Electric exciters—Type C D compound-wound, 96-amp., 110-v., 12-kw., 40-deg. C., 1800-r.p.m., driven by induction motors, General Electric type K T, 3-phase, 60-cycle, 440-v., 45-amp., 1750-r.p.m.

1 Pump, centrifugal—Goulds Mfg. Co. 1000-g.p.m., 1750 r.p.m.

1 Pump, centrifugal—Goulds Mfg. Co., 500-g.p.m., 1800-r.p.m.

1 General Electric motor, induction, for 1000-gal. centrifugal pump drive—20-hp. induction motor, 3-phase, 60-cycle, 440-v.

1 General Electric motor, induction, for 500-gal. centrifugal pump drive—15-hp. induction motor—3-phase, 60-cycle, 440-v.

1 Stacking machine—Gifford-Wood Co., 300-block, 8 tiers.

1 Ice crane—Euclid Crane & Hoist Co., 2½ t.

1 Ice hoist—Euclid Crane & Hoist Co., operated by electric motor; capacity, 8 cans, 2400 lb.

2 Air compressors for agitating water in cans—Pennsylvania Pump & Condenser Co., 14 in. by 9 in., 300-r.p.m., driven by 50-hp. General Electric induction motor, 3-phase, 60-cycle, 440-v., 40 deg. C.

1 Automatic receiver for air agitator—Ball Ice Machine Co.
High pressure air system, 30 lb. primary, 15 lb. secondary.

1 Scoring machine—Uline Ice Scoring Machine Co., 300 block capacity.

1 Yarway spray cooling pond—Yarnall-Waring Co.

40 Yarway spray nozzles—Yarnall-Waring Co., involute type.

1 Ammonia condenser—Henry Vogt Machine Co. vertical tubular type, 50-in. diameter by 16 ft. long.

1 Ice conveyor—Jeffrey Mfg. Co.

Recent Views of San Francisco's Great Hetch Hetchy Power Development

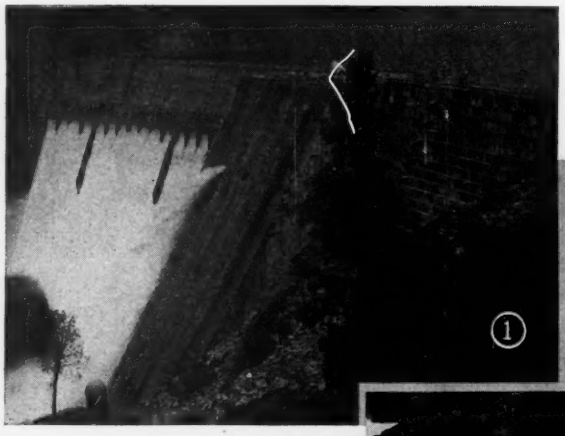


Fig. 1. O'Shaughnessy Dam, 156 mi. east of San Francisco and 12 mi. above Early Intake, with one of the 5-ft. needle valves discharging

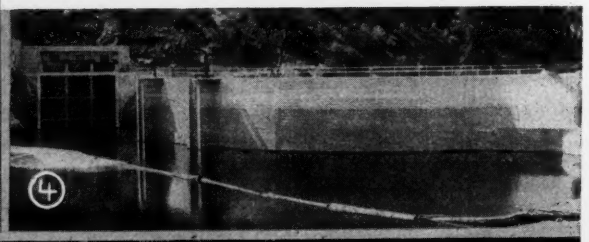


Fig. 2. Four steel penstocks bring water from Priest Reservoir to Moccasin Power House, with a drop of 1315 ft., whence it flows on to supply San Francisco

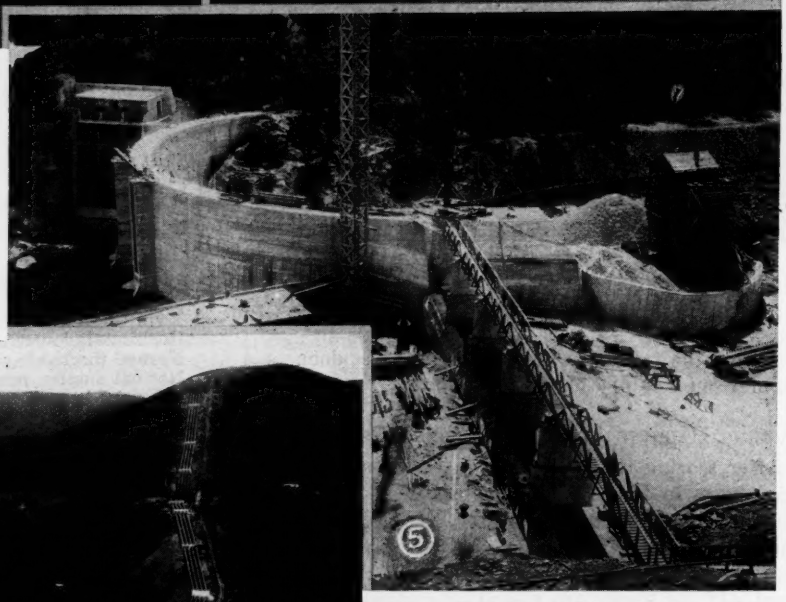


Fig. 3. Moccasin Power House is designed for an ultimate installation of 6 hydraulic turbine generators. Three of these are shown here, each generator being rated at 20,000 kv.a., 87.5 per cent power factor, 11,000 v., driven at 257 r.p.m. by a double overhung 25,000-hp. impulse type turbine

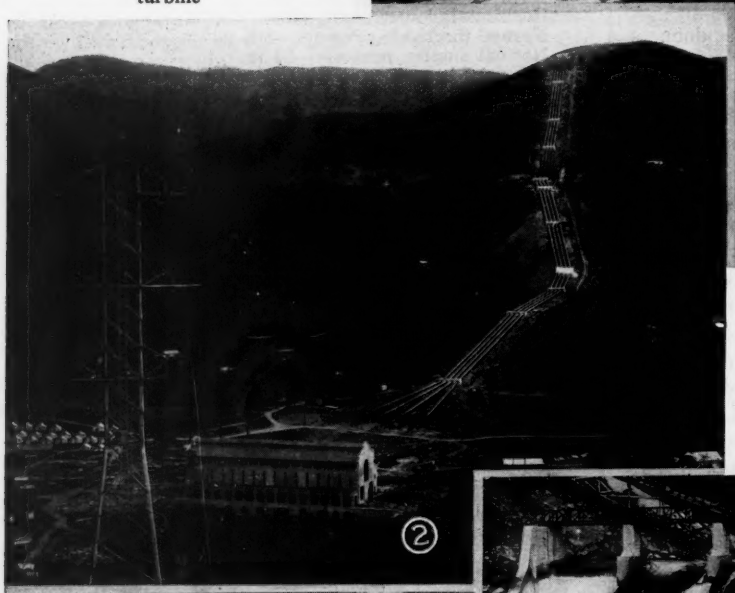
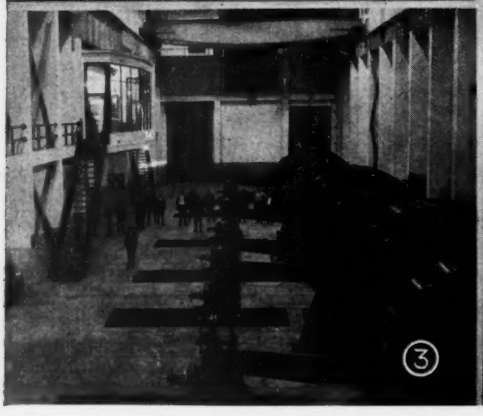
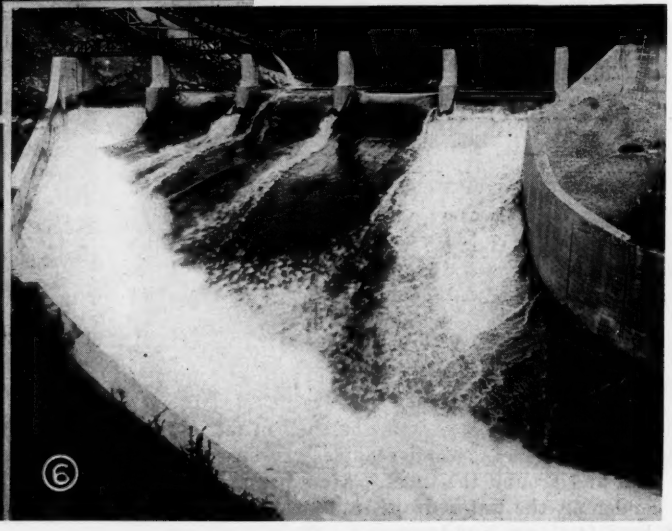


Fig. 4. Early Intake Diversion Dam, where water first enters tunnels on way to Moccasin

Fig. 5. View of Early Intake Dam during construction showing sluice gates and screens, arch dam construction and 20,000-c.f.s. spillway at right

Fig. 6. Spillway of Early Intake Dam in operation





Taxation on Power Production

SOME STATES ARE HANDICAPPING INDUSTRY AND HYDRAULIC DEVELOPMENT BY BURDENSOME LEVIES. BY WINGROVE BATHON*

GROWING tendency among the states to attempt to control hydroelectric production, irrespective of the Federal Water Power Act, by taxes, if by no other means, is engaging the attention of observers in Washington, Senate and House committees and executive departments such as the Federal Power Commission. This tendency is evidenced particularly in the Alabama and Tennessee instances, which will be discussed as object lessons (and possibly condemned in no uncertain language) at coming hearings in Washington on the Boulder Dam bill, the Columbia Basin and Umatilla projects, Muscle Shoals measures, combined flood relief and power bills and others.

In 1927 the legislature of Alabama passed a law levying a tax of two-fifths of one mill upon each kilowatt-hour of hydroelectric power manufactured and sold. The most recent reverberation of this in Washington was a demand by the State Tax Commission of Alabama upon the Secretary of War that the Federal Government should pay this tax to the state of Alabama upon all of the hydroelectric power manufactured and sold at the Wilson Dam at Muscle Shoals. When the writer called the attention of Senator Norris of Nebraska to this he intimated, informally, that he felt he would be justified in getting a measure through Congress which would deny the citizens of Alabama the use of the magnificent new road, which was built across the Wilson Dam by the Federal Government and happens to be part of the Dixie highway. Formal response, however, was sent by the Secretary of War's office to the chairman of the state tax commission of Alabama, calling his attention to the fact that such a tax is not applicable to the Federal Government since it has been held by the Supreme Court of the United States in several cases that the instrumentalities of the Federal Government are not subject to state taxation. This decision was handed down by Chief Justice Marshall more than a hundred years ago.

Tennessee has a more ambitious program under way, as shown by an announcement Nov. 1 by the Railroad and Public Utilities Commission of the State of Tennessee, known as Water Power Docket No. 1. In this, Tennessee undertakes to levy a tax of one mill per kilowatt-hour upon hydroelectric generation in that state. Tennessee not only wants a much larger tax than Alabama but it even goes so far as to attempt to levy a tax on all hydroelectric power generated, ignoring the question of whether it is sold or not and ignoring the amount of the losses between generation and sale.

These two cases come up just as congressional committees are about to begin work on various power matters. They represent traditional states' rights points of view. The ideas of the seven states involved in the Boulder Dam controversy, the attitude of Governor Smith of New York, and various controversies in other eastern states in regard to power matters, now are about to be aired but the Docket No. 1 of the commission in Tennessee furnishes some interesting points of view in regard to the discrepancy between the states' righters and the Federalists, in regard to power matters.

It is most important that, apparently, the State of Tennessee and the Federal Power Commission have buried the hatchet. Second, the Federal Power Commission has apparently decided to ignore, so far as Tennessee is concerned in this instance, the fact that it is not bound to give heed to any state in the selection of an applicant who shall receive a preliminary permit. State consent is required only as to the issuance of a license. The Power Commission may, however, give heed to a state on the issuance of permits and now apparently intends to do so. The third point brought out by this document is that the Railroad and Public Utilities Commission of Tennessee has adopted the Federal Power Act as its code of procedure; all of the conditions, except one, which it has laid down in its public announcement in that docket are those to which any Federal licensee would have to conform under the provisions of the Federal Water Power Act.

On its own initiative the Commission issued Water Power Docket No. 1 and an order requiring applicants for preliminary permits under the Federal Water Power Act to appear before and satisfy the Tennessee commission. Included among these applicants are the companies asking for permission to do preliminary work on the Cove Creek and ten other dam sites on the Upper Tennessee, the Clinch and the Powell Rivers. Action on these permits is being delayed pending the settlement of Muscle Shoals legislation, inasmuch as Cove Creek is regarded as an important proposed storage dam for the operation of the Muscle Shoals plant.

Imposition of a tax of one mill per kilowatt-hour is the one exception to Federal requirements. There is grave doubt in Washington about the legal authority of the Tennessee Commission to enforce such a tax as the condition of issuing a certificate of convenience and necessity and that point will probably be contested by one or more of the applicants; probably not, however, by any public utility applicant. Federal Power Co. and the Tennessee Hydroelectric Co., these two applicants for permits; are both manufacturing companies.

Considering the matter from the standpoint of policy, regardless of legality, it would seem that the Tennessee Commission has over-reached itself. In the first place, one mill a kilowatt-hour is based on the power *generated* at the power plants. This means that the tax would be placed on an enormous amount of power lost in transmission and distribution, from which power neither the company nor any consumer gets any benefit. These total losses, when carried down to house lamps and other small utilities, are large and the consumer would have to pay a tax on what he uses, also what is lost in transit to him, which in some cases might be twice or thrice the amount of tax contemplated by the commission.

All proposals heretofore made public in the different states, as well as in some of the Federal Government departments, base the tax on the power generated *and sold*. This one mill per kilowatt-hour is two and one-

*Washington Correspondent.

half times as much as was imposed by the Alabama Legislature. If it be distributed uniformly over all consumers, it penalizes all industry which uses power and light. For many power-using industries in Tennessee, this additional burden of one mill per kilowatt-hour will just about eat up all of the profits of those industries. Some are getting power as low as seven and eight mills per kilowatt-hour, so that an addition of one mill means an important increase in costs.

Unquestionably, the imposition of this one mill, if levied upon industrial users of power, will divert from the state of Tennessee industries which might otherwise go there, but which will choose states that do not impose such a tax. Also those industries already located in the state of Tennessee, whose profits are wiped out or largely curtailed, will move away from the state as fast as they can.

If, on the other hand, all of the one mill tax should be concentrated on small users, such as householders, it will mean a much greater burden than is apparently contemplated by the Commission. On first thought, one mill added to a consumer's rate of, say, six or seven cents per kilowatt-hour, appears a small matter, but it should be remembered that small consumers use only a minor percentage of the total power generated and sold by a public utility. In Tennessee the small consumers take about 33 per cent of the total production. Therefore, if all of the one mill comes back on household consumers, it will mean that 100 per cent of the tax is applied to 33 per cent of the power and such a tax will mean three mills instead of one mill.

Water power projects in Tennessee, to which this one mill tax will apply, will undoubtedly produce, according to the figures of the engineers, at least 3,000,000,000 kw-hr. per year. This would mean that the public would have to pay $3,000,000 more a year than it now pays for electricity. How will the small consumer of Tennessee regard a proposal to increase his utility rates by $3,000,000 more? Public utility companies have comparatively little concern as to the method a state may choose to raise its taxes. The question lies largely between the Railroad and Public Utilities Commission of the State of Tennessee and its constituents.

As to future development, the difference between hydroelectric and steam costs has become so small that an additional one mill burden on the hydroelectric cost will turn the scale in favor of steam power. That is so true that in Alabama, when the Alabama Power Co. filed with the Public Service Commission of that state an application for a certificate of convenience and necessity to build the first of four new plants, having an ultimate capacity of 200,000 kw., it was decided to build a steam plant in the Warrior coal fields in Walker County, Alabama. This first new unit will have a rating of 50,000 kw. and will cost $5,000,000. The total investment is to be about $20,000,000. When the Alabama legislature placed a tax of two-fifths of a mill on hydroelectric power, generated and sold, the same act increased the coal tax to two and one-half cents per ton. Figuring that a ton of coal will generate 2000 kilowatt-hours, the relation between the hydroelectric tax and the coal tax is about eighty cents to two and one-half cents. From this it will be seen that the power plant engineer must more and more take into consideration the subject of taxes in planning power plants.

Industrial Progress Research

INVESTIGATIONS of the progress in various industries and of causes for advance or depression is the object of the National Bureau of Economic Research. It is an organization for fact-finding, without profit to its members, directors or officers and the work is carried on without expense to those assisting by furnishing information. Reports may be published only on approval of the directors, any dissenting director having the right to have a minority report published with the majority report.

Completed reports have been made on Amount and Distribution of Income in the United States, 1909-1919, and a supplementary report on Sources and Distribution of Income in the Various States, 1919-1921, also tentative estimates for years up to 1926. During the depression of 1921 a survey was made and reported on of Business Cycles and Unemployment and of Employment, Hours and Earnings in Prosperity and Depression. Growth of American Trade Unions, 1880-1923, was another report, also investigation was made of Migration and Business Cycles and reports on Business Annals is a study of business cycles which is kept up as a continuous study.

At present studies are under way of the labor market, bond yields and interest rates, immigration statistics for all countries and the effect of restriction on labor-saving machinery.

The bureau is about to undertake a survey of changing productivity to ascertain as accurately as possible the production per hour of labor for a selected group of manufacturing and construction industries over the past thirty years.

Factory and construction executives who have records over all or any part of the period, which will permit computation of product per hour of labor, are asked to write to the bureau at 474 W. 24th St., New York N. Y., and indicate the nature of those records. No expense will be incurred by those furnishing information, but a representative of the bureau will call to study the information available. Results of the investigation will be furnished to all who assist in the work for such private use as they may wish to make of it. No information as to individual establishments will be divulged but comparisons will be made as to labor per unit of finished product and as to effect of changes in method, equipment and wage payments on the labor required per unit of product.

Co-operation with the bureau is a method of assisting in solving the economic and labor problems of industry and results of these investigations have shown the reliability of the bureau's work.

Financing is by voluntary contributions of organizations and individuals interested in economic research, but furnishing of data in no way obligates to financial support of the work.

Boiler Water Tests Should Be Utilized

IN THE ARTICLE under the above heading on page 895 of the August 15 issue an error appears which has been called to attention by the author. In Table I line 7 reads "30 minus 15 equals 15 caustic soda." This should read: "30 minus 10 equals 20 caustic soda" and the next line should read: "20 multiplied by 1.13 equals 22,6 gr. per gal. of caustic soda."

The High Cost of Fuel Saving

I NOTE with much interest the comment in the November 1 issue on Mr. Trinks' proposal that the government place a tax on fuel in order to effect its conservation. It would seem that such a course would be tantamount to an admission that fuel engineers and manufacturers of fuel burning equipment are approaching the limit of their ability to design and put on the market equipment of such high efficiency and such low cost that the smallest plant would be justified in replacing inefficient apparatus with the improved type. Certainly this stage has not yet been reached.

It seems quite unlikely that the proposed scheme of taxation would succeed in its ultimate purpose, for the costs of administration would undoubtedly far exceed any savings that might be realized. There are also other undesirable features as have been mentioned.

As a counter proposal it might be suggested that engineers and manufacturers put forth greater efforts to perfect the design and reduce the cost of fuel-burning equipment, and perhaps arrange terms of sale similar to those under which a certain type of steam engine has been sold, that is, payment to be made with the savings realized from the greater economy of the new equipment. As an incentive to such effort the government might offer a yearly prize to the manufacturer who succeeded in making the greatest increase in efficiency and the greatest reduction in cost of such equipment, the money value of the prize to be great enough to more than repay efforts made to obtain it. Improvements are constantly being made but the difference in efficiency and cost between the old and the new apparatus should be great enough to insure widespread adoption.

In this connection the need of continued improvement in pulverized fuel equipment might be mentioned. Utilization of coal in pulverized form is one of the most efficient methods of firing solid fuel, yet the cost of equipment and installation is not yet low enough to warrant its installation in all of the smaller furnaces where it might otherwise be suitable.

Many hundreds of pounds of iron assembled into a bulky machine are required to pulverize a few pounds of coal per hour. A motor requiring wiring and switches is necessary to drive the machine in most cases. The existing furnace must in many instances be torn down wholly or in part and rebuilt in order to burn successfully this new fuel.

Why tax fuel and still further increase the cost of producing much needed equipment?

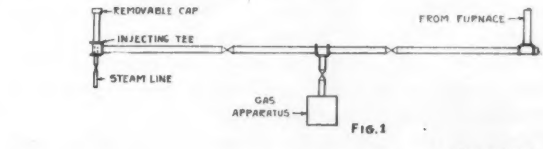
As an instance of enormous saving effected by continued improvement in efficiency and at the same time lowering of cost, the incandescent lamp might be mentioned. This lighting device has been so highly perfected, and placed on the market at such a low price, that it is many times cheaper to use than a candle.

No tax on electricity was required to effect a saving in this source of power, even the poorest household being able and willing to make the expenditure for such an indispensable product.

Schenectady, N. Y. S. C. MARTIN.

Piping Connections for Sampling Flue Gas

"PIPING CONNECTIONS for Sampling Flue Gas" by E. J. Morrissey, published on page 1161 of the November 1 issue, interested me much. There are a few



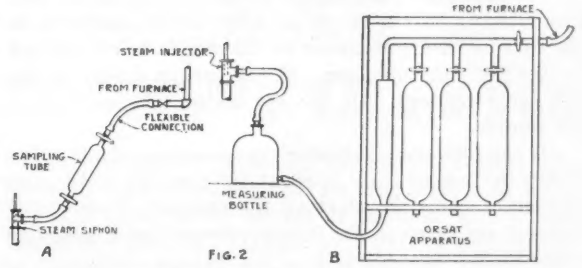


FIG. 1. CONNECTIONS WHICH PERMIT OF USE OF STEAM FOR EITHER BLOWING OUT OR SAMPLING FLUE GAS

FIG. 2. CONNECTIONS SHOWING HOW SAMPLE CAN BE DRAWN DIRECTLY INTO ORSAT DEVICE BY MEANS OF AN EJECTOR

thoughts, however, on his arrangement and method of sampling the flue gases that come to mind.

First, I would be afraid to trust having two high pressure lines such as a steam line and a compressed air line connected to my sampling line. While the lines may have good valves, there is always a possibility of an air or a steam leak in the valves. This would be particularly true where the valves are used intermittently and are located near a hot furnace or boiler. It would take only a very small leak to render worthless the flue gas analysis.

If necessary to blow out the sampling line, it would be better to have a plug in the right tee to which the steam line may be connected. Upon completion of the blowing out process, I would disconnect the steam line entirely and replug the tee, thus removing all possibility of a steam leak into the sampling line.

Second, I don't see the advantage of having both air and steam lines, as steam could be used for both blowing out and sucking out the gases. I would personally prefer the steam to the air, as it is a cheaper fluid, usually of higher pressure, and having a better scouring action. It would also syphon better due to its higher pressure and it is usually more easily procured, little piping being required, especially around a boiler plant, where steam lines are numerous and air must be piped specially. Figure 1 shows the arrangement I would use for this method of sampling and blowing out.

In taking samples directly from the boiler or furnace, I believe it would be quicker and more accurate to put the sampling tube or Orsat directly in line or series with the ejector, passing the flue gas through the gas analysis apparatus.

Two arrangements in one of which the sampling tube is used and in the other showing how the sample can be taken directly in the Orsat by means of the ejector are illustrated in Fig. 2. In this way, there can be no adulteration of the sample by the ejector air or steam. By blowing the gases through the measuring bottle, the water becomes more or less saturated with the flue gases, minimizing absorption of portions of the flue gas samples in the measuring bottle water. When sufficient gas has been drawn through the apparatus to insure a good sample, the suction need only be shut off and the sample brought to 100 c.c. in the burette by means of the measuring bottle. Instead of piping the lines for blowing out, it might be better to change the hot ends at intervals, avoiding plugging up, etc.

Third, if the furnace is hot enough to soften and fuse the end of the sampling tube which protrudes in the furnace, there is danger of the sample being affected by the red hot tube, some of the carbon oxides in the gas being reduced. Or the hot scaled tube may affect the sample.

If samples are taken near the breeching of the boiler where the temperature is about 600 deg. F., there is no danger of chemical effect on the sample. However, if samples are taken in the furnace, water cooled sampling tubes should be used.

Dayton, O. FRED EMMARR.

Simple Armature Repair

SOMETIMES an engineer is compelled to repair a burnt out or open coil in an armature winding. Delay in repairing such a defect may be serious if the machine is the sole exciter for an alternator as is frequently the case.

Repairs of this kind may be made by first cleaning out the mica between the segments at the place where the trouble has been located, to a depth of about ⅜ in., depending on conditions, by means of a hacksaw. All of the mica must be removed so as to provide a good electrical contact between the segment parts. At this point a small copper wedge of such thickness that it will be held firmly without distorting the winding is driven in, any protruding portion being filed down and the adjacent part of the commutator slightly upset over the wedge by means of a small punch or chisel in order to eliminate any possibility of the wedge flying out while the machine is running.

Another method of making this repair is by use of a copper wire bent in a "U" shape, its ends being set between the segments affected, one at the right and the other at the left side of the two segments and the ends soldered to the ends of the segments.

In the case of a short-circuited coil, the same repair can be used but the defective coils must be cut in two. This can generally be best done at the back end of the armature near the core. When repairing an open circuit, it is good practice to remove one of the leads of the defective coil from the commutator so as to prevent a short circuit of the coil if the open portion should happen to close again.

West Vancouver, B. C., Can. JAMES E. NOBLE.

Counterflow and Uniflow Noncondensing Engine Economies

ON PAGE 950 of the September 1 issue A. F. Sheehan states that he does not agree with the reasons as given in my article on the relative economies of noncondensing Corliss and uniflow in the July 15 issue, page 798.

In my former article I cited a uniflow engine that had clearance spaces in the cylinder head and, for noncondensing operation, used a piston with cupped ends to provide further clearance. The compression stroke was 90 per cent. Mr. Sheehan states that this probable arrangement and the fact that the Corliss had approximately 25 per cent greater piston displacement, accounts for the differences in the economies. He further states that better economies are obtained if the uniflow is equipped with auxiliary exhaust valves located away from the cylinder head.

Whether or not the reasons as given by Mr. Sheehan are correct, can only be determined by a thorough study of the subject. In his treatise on "The Una-Flow Steam Engine," Professor Stumpf clearly recognized the limitations of the uniflow engine for non-condensing operation. He made a comparative study of an engine equipped with both clearance spaces and auxiliary exhaust valves. For the former he found that the increase in steam consumption was 0.158 lb. per hp-hr. with superheated steam, and 0.202 lb. with saturated steam for each per cent of additional clearance and noncondensing operation. The corresponding increase with auxiliary valves, superheated steam and noncondensing operation was 0.264 lb. He does not cite any value with saturated steam, but it can easily be guessed that it is much higher than with superheated steam.

Professor Stumpf shows the corresponding types of cards for the two cases, and discusses the various factors which enter into the problem of the increased steam consumption in the case of the auxiliary exhaust valves. He shows that with clearance spaces the engine still retains its series arrangement of live steam space, inlet valve, piston and exhaust, which is such an important feature of the uniflow. He stresses this series arrangement more than anything else in the text. In the case of the auxiliary exhaust valves he states that even though the expansion is complete, the action is partly uniflow and partly counterflow for loads higher than normal; for loads less than normal there is an over expansion with its subsequent loop, and backflow of steam into the cylinder, which of course is counterflow

action. Such action increases the initial condensation losses the same as in the ordinary counterflow engine.

Professor Stumpf states that the loop at the end of expansion cannot occur in engines fitted with additional clearance space. He states that the worst feature of auxiliary exhaust valves is their detrimental effect on the uniflow principle. They increase the clearance space and the harmful surfaces, as well as the probability of leakage, at the same time sacrificing the valuable series arrangement of the uniflow. Yet for long periods of noncondensing operation as in winter running, he recommends the use of auxiliary exhaust valves in preference to clearance spaces. This is in spite of the considerable increase in the steam consumption, as shown above. It is not clear to me how the auxiliary exhaust valves located away from the cylinder head, as Mr. Sheehan recommends, would modify the action of the steam in the cylinder other than that discussed by Professor Stumpf.

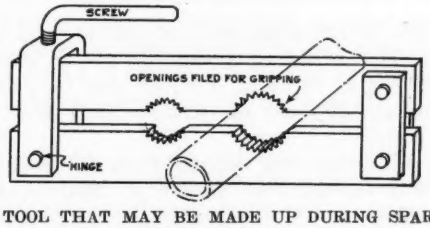
If, as Professor Stumpf shows, an engine with clearance spaces gives better economies than when equipped with auxiliary exhaust valves, how is it possible to obtain a horsepower-hour on 18.5 lb. for the latter with saturated steam when published results for the former seldom if ever show less than 20 lb.?

As for having a greater expansion ratio, the fact is, the condensation losses are so much greater for the Corliss that the advantage of more complete expansion has hardly any effect on the economy. In the case of the uniflow such losses are greatly minimized by the fact that the engine, even though operating noncondensing, still has the series arrangement. Hence the uniflow engine should do better than the counterflow engine in the matter of economy. For condensing operation it does; for non-condensing—it does not.

State College, Pa. A. J. Nicholas.

Small Pipe Line Installation

Use of small brass pipe and fittings for water or oil pressures of 100 lb. or over, is certain to cause trouble if due consideration is not given to making up the joints



HANDY TOOL THAT MAY BE MADE UP DURING SPARE TIME FOR USE AS PIPE WRENCH OR IN VISE

with linen thread or to sweating them in order to prevent leakage. Small commercial brass fittings are quite soft and when the pipe is screwed into these solid enough to prevent leakage, the fittings frequently expand and become quite loose.

Quarter-inch pipe control lines serving quick closing oil valves were installed in several plants that had been under the charge of the writer. The controls were at a distant point so as to permit closing off the lines in an emergency. Sweating all connections in a brass line proved to be most successful, the pipe ends and the threads in each case being first tinned.

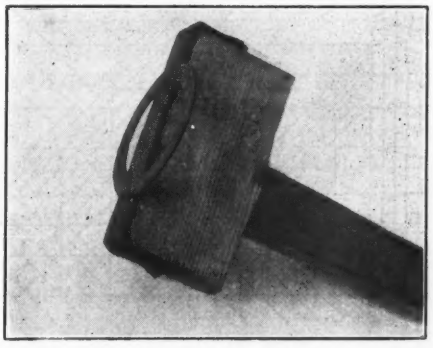
Because of the damage usually done to piping when handled by the usual wrench, several clamps, as shown in the sketch, were made up from rectangular bar stock and fitted with clamps and hinges. The teeth were hardened and tempered in order to retain their sharpness and the edges were rounded for protection of the hands.

This tool not only served as a hand tool but was as readily used in a vise, gripping it in the manner that pipe jaws are usually gripped. Contact of teeth on four sides of the piece in the tool overcame the usual tendency for the pipe to cut or collapse. The tool may be used as a pipe wrench on brass pipe or thin tubing or if gripped in a vise is useful for bench work.

Washington, D. C. G. A. Luers.

No Bait Needed

Some flat copper gaskets fell down to the bottom of a tank and an odd but practical little device was made to fish them out. Several turns of electrician's



STRIPS OF ADHESIVE TAPE PROVIDE MEANS FOR FISHING OUT COPPER GASKETS WHICH HAVE DROPPED IN TANK OF WATER

adhesive tape were tacked to the end of a short 1-in. block. To the block was nailed a long stick with which it was lowered to the bottom of the tank and pressed against the gaskets. Though lying flat, the tape picked up the heavy gaskets and held them with a surprising tenacity.

Missouri Valley, Iowa. Frank W. Bentley, Jr.

Home-Made Protection Serves Well on Blowoff Pipe

Home-made protectors permanently remedied trouble with a blowoff pipe after protective brickwork had repeatedly broken down and old cast-iron pipe, which had been placed outside of the blowoff pipe burned out and the blowoff pipe badly damaged.

Using the old blowoff pipe, which was replaced by new pipe, forms were made and shapes cast of pulverized old fire bricks and fire clay. After these shapes had partially dried out they were baked in the furnace of the boiler by being heated to redness for a few hours and then slowly cooled. The old fire bricks were pulverized by pounding them with a hammer and sifting through quarter-inch wire cloth. This was then mixed with water.

Later, some dry, ready-mixed firebrick material was procured which proved more satisfactory than the old bricks.

Indianapolis, Ind. James F. Hobart.

QUESTIONS AND ANSWERS

Comparison of Fuel Costs

WHAT ARE the comparative costs per thousand B.t.u. of burning coal and oil under a boiler with the following characteristics:

Coal: 13,500 B.t.u. per lb.; costs $4.09 per ton.

Oil: 29 Baume; 7.345 lb. per gal.; 19,210 B.t.u. per lb.; costs 6.25 cents per gal. A. B.

A. In comparing relative costs of oil and coal, the fixed and operating costs and also insurance, depreciation and maintenance charges must be considered. The fixed and operating costs for oil are relatively low when a number of boilers are in use as one man can easily take care of from eight to ten boilers. Standby losses, in the case of oil burning, are also reduced to a minimum because the boiler capacity can almost instantly be adjusted to the load and banking periods are entirely eliminated. On the other hand, insurance charges are usually high due to the high fire hazard and unless the furnace design is good, the maintenance charges may be excessive. In calculating ultimate economies, these charges should be summed up and expressed as so much per pound of fuel fired. Since data on these factors have not been given and since local conditions change them, they will not be considered in the following comparison.

Efficiency of heat generation and transference also differs slightly in coal and oil burning. As the comparative efficiencies have not been stated, the efficiency of the boiler when coal is burned will be assumed to be 70 per cent and that when oil is burned, 75 per cent.

Referring to the chart, we may obtain the relative costs of coal and oil for equal economy. Starting on the right of the diagram with the cost of coal at $4.00 per t., go to the left to the 70 per cent coal burning efficiency, then up to the 13,500 B.t.u. per lb. for coal, then over again to 19,000 B.t.u. per lb. for oil, then down to 75 per cent oil burning efficiency and then over to 29 deg. Baume, and from there slantingly downward

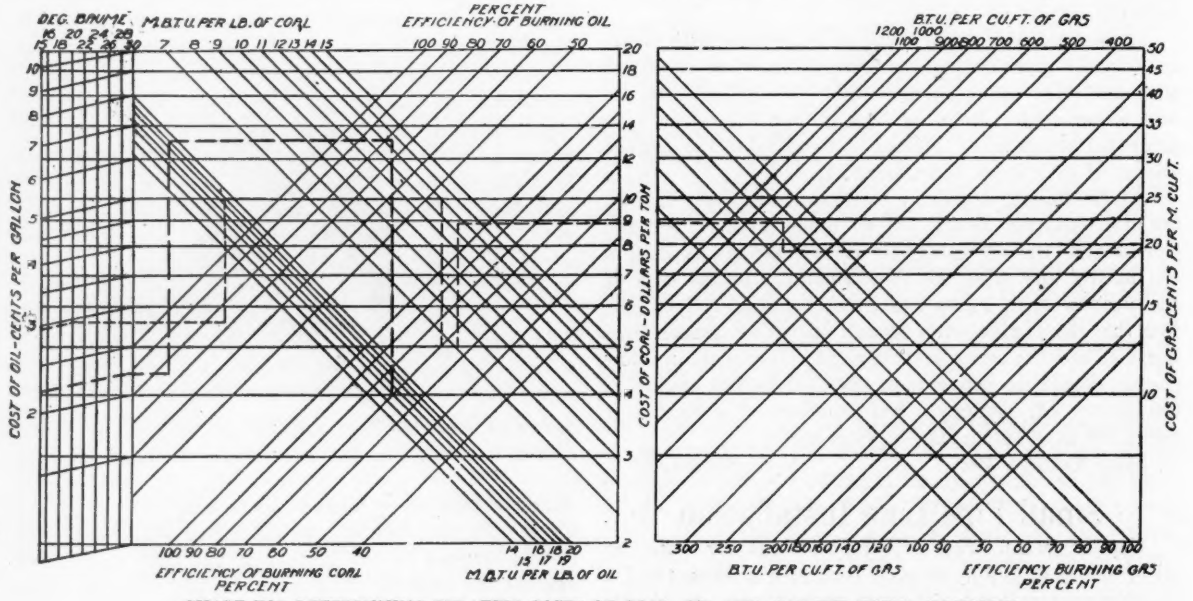

DEG. BAUME
M.B.T.U. PER LB. OF COAL
PERCENT EFFICIENCY OF BURNING OIL
B.T.U. PER CU.FT. OF GAS
COST OF OIL-CENTS PER GALLON
COST OF COAL-DOLLARS PER TON
COST OF GAS-CENTS PER M. CU.FT.
EFFICIENCY OF BURNING COAL PERCENT
M.B.T.U PER LB. OF OIL
B.T.U. PER CU.FT. OF GAS
EFFICIENCY BURNING GAS PERCENT

CHART FOR DETERMINING RELATIVE COSTS OF COAL, OIL AND GAS FOR EQUAL ECONOMY

to the left to the price, we find this to be 2.20 cents per gal. That is, for equal economy the oil should cost only 2.20 cents. We find, however, that the actual cost of the oil is 6.25 cents or (6.25 ÷ 2.20) more than it should cost.

The B.t.u. per ton derived from the coal-burning boiler will therefore be 13,500 × 2000 × 0.75 = 20,250,000.

The cost per thousand B.t.u. when coal is used will, therefore, be 4.09 ÷ 20,250 = 0.0002 cents. The oil cost would then be 6.25 ÷ 2.20 × 0.0002 = 0.00057 cents per thousand B.t.u.

Boiler Problems

KINDLY let me know the following:

1. How many square feet of heating surface will be contained in 66 tubes 4 in. diameter and 18 ft. long?

2. A boiler evaporates 2600 lb. water per hr. using coal that evaporate 8½ lb. water per pound of coal. If the grate is 6½ by 5 ft. what is the rate of combustion per sq. ft. grate surface per hr.?

3. What will be the total pressure against the disk of a 3-in. safety valve when the steam pressure is 120 lb. per sq. in.? L. J. W.

A. The circumference corresponding to 4 in. diam. is $4 \times 3.1416 = 12.56$ in. The area of each tube will be $12.56 \times 18 \times 12 = 2712.96$ sq. in. and the total heating surface will be $2712.96 \times 66 = 179{,}055$ sq. in. or 14,921 sq. ft.

2. Pounds of coal required to evaporate 2600 lb. water will be $2600 \div 8.5 = 306$.

Area of grate $= 6.5 \times 5 = 32.5$ sq. ft.

Rate of combustion $= 306 \div 32.5 = 9$ lb. coal per sq. ft. of grate per hr.

3. Area of a safety valve 3 in. diam. $= (3.1416 \div 4) \times 3^2 = 7.0686$ sq. in. The total pressure will then be $7.0686 \times 120 = 848$ lb.

Steam Plant Operation

PLEASE ANSWER the following questions for me:

1. How do you find the absolute temperature of steam?

2. How would you proceed to take an indicator card if there were no indicator cocks?

3. How would you find the size of steam pipe necessary for a battery of boilers carrying 80 lb. pressure in one case and 120 lb. in another?

4. What is meant by "seal" on a heating system? T. J. L.

A. Absolute zero is 491.6 deg. F. below the temperature of melting ice which is roughly 32 deg. F. In order to find the absolute temperature of steam of a certain pressure we add $(491.6 - 32 = 459.6)$ or usually the round figure 460 to the temperature of steam at that pressure as given in standard steam tables.

2. Drill holes in the sides of the cylinder, being careful to see that the hole enters the clearance space in each end of the cylinder and that the piston in its extreme end of stroke does not cover this hole. These holes may then be tapped and indicator cocks fitted.

3. The quantity of steam passed is affected by the specific volume of the steam which is determined by the pressure. The simplest and most common formula for the flow of steam through pipes is based upon an allowable steam velocity of 6000 ft. per min., friction and other causes of drop in pressure being disregarded. Under these circumstances we have $d = 0.175 \sqrt{w \div y}$

where d = inside diameter of pipe in inches,
w = weight of steam flowing in lb. per min.,
y = density of steam in lb. per cu. ft.

It will be seen that the number of pounds of steam, w, passing through the pipe per minute, which you have not stated, must be known. This will be found by knowing the capacity of the boilers feeding the line at the point at which the size of pipe is to be determined.

The value of y is found in a table on Properties of Steam. There will be two different values for y, one for a pressure of 80 lb. and another for a pressure of 120 lb.

By dividing the weight of steam flowing, in pounds per minute, by the density of the steam at the steam pressure in pounds per cu. ft., and multiplying the square root of this by 0.175, you will obtain the diameter of the pipe in inches, for this steam pressure.

4. Water seals are used on steam heating systems to permit drip or condensation to be removed from the system without loss of steam. In any steam heating system, therefore, any drip, relief, return riser or connection, from the steam to the return side of the system must be sealed.

Air Lift Pumping Has Limits

WOULD IT be practicable to lift water by compressed air from a well 160 ft. deep and raise it to a tank 70 ft. high? The tank is about 120 ft. distant from the well. The well supplies about 15 to 20 gal. per min. When not pumping, the water rises to about 60 ft. of surface of casing.

2. Would the air lift system work successfully for a well 103 ft. below ground level, the water standing in the well 40 ft. below ground level? The casing is 4 ft. diameter and is driven to solid rock 16 ft. below ground level. The water must be elevated 25 ft. above the ground. What would be the proper submergence, the size of air line and size of water discharge line? What would be the maximum capacity of the well? B. T.

A. Satisfactory pumping by air lift could not be accomplished in the first case if elevation is to be into tank, even without any drop, as the percentage of submergence is too low. The percentage of submergence, which is the ratio of the submergence to the sum of submergence and lift is $100 \div (160 + 70) = 43\frac{1}{2}$ per cent. For a total lift of 230 ft. the best submergence percentage should be from 55 to 60 per cent. We would recommend lifting the water to the surface with air and using a centrifugal pump for the elevators.

2. Assuming a drop of 10 ft. since the water is standing in the well and therefore is static, the total lift will be $65 + 10 = 75$ ft. With a submergence of 50 ft. or 40 per cent, it would require approximately 0.86 cu. ft. of actual free air to pump 1 gal. of water. If the compressor will deliver 7 ft. per min., the maximum amount of water that can be pumped is 8.15 gal. per min. at a working pressure of 25 lb. We would recommend the use of 1½-in. discharge pipe and ½-in. air line.

Scaling Device Removes Deposit from Condenser Pipes

WHAT IS the best method of removing the rust and scale from the outside of atmospheric ammonia condensers? The pipes of our condenser cannot be spread so as to get any kind of hammer cleaner through to the center pipes. H. M. S.

A. The deposit which usually forms on the outside of atmospheric ammonia condensers is calcium carbonate. Being brown in color, it resembles rust. This deposit is perhaps best removed by means of a hand tool consisting of two jaws, with teeth, which surround the pipe. By rocking the tool right and left the teeth, which are renewable, break up the deposit and the tool moves longitudinally along the pipe. Tools of this kind are in the market.

Another method frequently employed is to wrap a piece of chain once around the pipe and pull alternately on the ends.

EDITORIAL COMMENT

Can We Ever Catch Up with Science?

Proposals have been made in all seriousness, according to a recent report, that scientists should take a 10-yr. holiday to allow the rest of the world to catch up with them. Those who make such proposals, however, show what seems to us either a lamentable ignorance or a deliberate disregard for the human aspects of the situation. First of all, what would we do with the scientists themselves during this 10-yr. period? Second, man does not live by science alone, for if he did, in the light of even the insignificant amount of knowledge now available, he would already have produced a race of supermen. Instead, man lives by a something that one group would have us call religion, another group instinct, another group something else. Third, in the light of what everyone of us knows about human nature, why should we assume that anyone is capable of gaining any accurate, usable knowledge of that vast quantity of facts that science is piling up for us. Few of us have the natural intelligence to grasp them and still fewer have the instinct for using them.

Let us take, as an example of this reasoning, the cases of the various engineering projects that are constantly made political footballs in this country: water supply projects, municipal works, great hydro developments and the like. Surely, if the mayor of a great city, the governor of a state, the Congress of the United States, desire all the known facts about one of these projects on which to base a decision, these facts are fully available to them, as every engineer knows. In fact, they can command more information than the private citizen about any of these projects, all carefully arranged, tabulated, diagrammed, and in a form as clear as possible. Yet do politicians and statesmen base their decisions always on the known facts about a given situation? Do they even attempt to secure all the available facts? Any intelligent schoolboy knows the answers to these questions.

Is it any different, to take another example, in the field of medicine and public health? What has been done in stamping out yellow fever and smallpox could probably be done with many other diseases, thus appreciably lengthening human life. Why then does not society take the proper measures to do this?

"Man does not live by bread alone" said the Great Teacher, who was also a keen student of humanity. Man does not choose his wife by science, does not cast his vote by science, does not form his judgments of an applicant for a job by science, does not choose a friend by science, does not hate an enemy by science. For one thing, he has not the intelligence and it may be questioned whether he ever will have. Far more important is the fact that science, as such, has no concern with human nature. This is no condemnation of science, nor of man for not having the intelligence to take full advantage of science. It is rather a recognition of something far more powerful than pure intellect.

No, we fear that a 10-yr. scientific holiday would not permit humanity to catch up with science.

Advancing Steam Pressures

Many years ago scientists pointed out the theoretical advantages of using the higher steam pressures. So many practical limitations, however, arose that the actual advance into the commercial use of steam at modern high pressures started only about 10 yr. ago. Since that time, practically every device used in the generation and utilization of steam in a power plant has undergone changes in design to meet not only high pressures but the more perplexing problems of high temperature and exacting operating conditions.

In adopting high pressure, first consideration is given to the economy which such an installation will give over the more moderate pressures. Constant increase in the number of plants which are designed for real high pressures is evidence that equipment for such pressures is now commercially available. This has been the real deterring factor in the progress towards higher pressures and now that the industry has demonstrated the value of steam pressures in the neighborhood of 1200 lb., manufacturers may be assured of a market for equipment developed to meet the exacting conditions imposed in the modern high pressure steam plant.

All along the line of development, safety in operation has been a prime requisite and it is a noteworthy fact that not one of the high pressure plants has met with a disastrous failure due to the use of high pressure. This is evidence that the steam containers—boilers, piping, turbines—have been successfully designed but engineers experience difficulties in making the auxiliary equipment withstand the severe conditions to be met. The safety valve built for moderate pressures is not suited to temperatures of 1200 lb. steam and an entirely different design has been found necessary. Gage glasses for the highest pressures have little resemblance to former types, either in design or material used. Feed water regulation requirements are so severe that some operators deem hand control necessary, though that situation is now being successfully met by the manufacturers. Scale in the boiler and corrosion of tubes and plates would be disastrous, so special feed water treatment is necessary. One by one, as experience develops weak places in the system, the various auxiliaries are being entirely redesigned for the new conditions.

Advancing steam pressure has unquestionably revolutionized the steam power industry, not replacing entirely the old order of things but offering a new field built upon the experiences of the old which is bound to grow until its economic limitations are reached in the industrial as well as in the central station field.

Write Your Own Moral—If Any

Many years ago—more years than the writer likes to think about—he was employed, during his freshman summer in college, in the engineering department of a large textile mill. In the same department was Paul Thompson, his "buddy," also a college freshman. The chief engineer, old Bill Davis, was a "practical" man and had little use for this "high-falutin theory" that boys got filled with in colleges. Nevertheless, old Bill was a just man, although a stern and relentless taskmaster, and he had a feeling that there was some hope for the boys despite their book learnin'. They, of course, thought they were very clever fellows.

One of old Bill's methods of attempting to embarrass the boys was to ask them, "Now, suppose the old water wheel over in No. 2 mill should go down into the pit, what would you do to get her up again?" On every conceivable occasion he would ask the two boys this question. The two would immediately begin to ask what the hypothetical conditions were, what might be the trouble, what apparatus was available to work with and so on. But the chief would never listen to them; none of their answers or suggestions of procedure could suit him. Always they were met by a scornful snort. "Huh! Never mind all that. If she goes down, you haven't got time to stand around gassing about all those things. You've got to *do* something! What would you do?"

The old water wheel, set in a pit with the old-fashioned conical step bearing, drove an ancient weave shed through wooden bevel gears and was its only source of power. Although the boys agreed that something would have to be done if the wheel went down, they were pestered by old Bill with his trick question so often and their suggestions so consistently belittled, that the old chief began to be somewhat unpopular with them.

One morning, as the writer was coming to work, he rounded the corner of the boiler house and almost fell over Paul. The boy was seated on a box and appeared to be in a violent paroxysm of sorrow. Tears rolled down his face, he rocked back and forth, he moaned. It was several minutes before the writer discovered that he was laughing so hard that he cried.

"Matter!" he gurgled, when he could control himself. "What's the matter, huh! Wait till you see it! Last night—six-thirty—everyone gone but old Bill—step on No. 2 water wheel burns out—down she goes into the pit! Bill—haw! haw!—he stayed all night—haw! haw! haw!—and he hasn't yet figured out a way to get the darned thing up!!!"

Industrial Markets Are Not Were They Used to Be

American industry is transitory, not stationary, and this fact should be kept firmly in mind by every industrial executive. Just now we are witnessing a gradual shifting of industrial centers. The increasing and ever changing population, coupled with the development of new sources of raw materials, gives rise to new routes and methods of transportation, and makes necessary constant alteration to industrial methods and marketing practice.

Not so long ago New England was the industrial center of the United States. This was because New England was for the most part peopled by folks trained in the industries of Great Britain. Today the shoe and leather industry is scattered from one end of the continent to the other, while the textile industry is rapidly spreading itself over the South where the raw material, water power, cheap labor, and fair transportation may be found.

Canada and Wisconsin are rapidly undermining the supremacy of Maine and Massachusetts in paper making; California and the Southwest have taken predominance from the Keystone state in the matter of oil; while Pittsburgh has suffered by the inroads to both prestige and production made by the Lake Michigan plants.

Any plan for marketing finished products must take into consideration the westward shifting center of population—formerly in eastern Pennsylvania, now in a western Indiana village. Manufacturers have met the situation by what is commonly known as decentralization, or by moving themselves bodily to the newer and larger fields.

New inventions and trends of thought play an important part in marketing. Style changes are carried swiftly by radio, press and motion pictures, with the result that San Francisco knows and incorporates changes as quickly as New York. The "Black Bottom" is danced in the logging towns of Wisconsin to the strains of the same orchestra as the dancers on a Manhattan roof garden, because of radio. There is no remoteness any more. Articles which sell in the East will likely find the same appeal in the West. Labor-saving devices and industrial innovations are as eagerly sought in one section of the country as in another. We are rapidly becoming a closely knit and amalgamated land, manufacturing and marketing. The executive who recognizes the shifting tide of population, similarity of intersectional tastes and desires, new routes of transportation and new centers for manufacturing, is an alert official and the one most likely to reap the largest harvest from the advertising and selling effort that he bases on his cold analysis of the facts of today's United States.

Senator George W. Norris of Nebraska, who has long fought government operation of Muscle Shoals power plants, has publicly stated that, after visiting the Lazote nitrogen plant of the DuPont Co., near Charleston, W. Va., he is convinced that it would be "nothing less than criminal to try to use the water power developed at Muscle Shoals for manufacture of fertilizer by the cyanamid process."

Operating on a modification of the Haber synthetic process, the Lazote plant demonstrates that the cyanamid process is out of date. Senator Norris states that for $12,000,000 synthetic process plants can be built to extract 40,000 t. of nitrogen annually from the air—the amount that could be made at Muscle Shoals—at less cost and with use of much less power than by the cyanamid process. The amount required could quickly be realized by sale of power from the Shoals plant by the government and thereafter a substantial revenue would accrue from both power and fertilizer activities, as against a probable deficit if the Shoals power was used for fertilizer manufacture by the cyanamid method.

Power Plant Equipment Epitomized

LATEST DEVELOPMENTS TO BE FOUND AT GRAND CENTRAL PALACE, NEW YORK, SHOWING LOCATIONS OF BOOTHS AND WHAT THEY CONTAIN

HERE IN THE four floors of the power show are gathered the latest in equipment, accessories and materials for the power plant engineer. Each exhibit will have a worth while message for the visitor and by the use of the directory which follows it will be possible to plan inspection of the booths so as to cover those displays in which the visitor is most interested, although he should by no means overlook any of the exhibits. As will be noted from the floor plan, the first floor has booths from 2 to 101, numbering starting from the left on the 47th St. side and running around the walls up to 28 and then running back and forth lengthwise of the hall, the numbers 30 to 59 being to the right of the main entrance and 60 to 94 to the left of the main entrance. Booth 95 is on the 46th St. side near the front corner of the building, and booths 98 to 101 on the 47th St. side near the front corner of the hall. Booths A and B are to the left and right of the main stairway, and Booth M is found at the right of the far end of the main isle.

On the second floor will be found booths 201 to 347, the numbering starting from the front left-hand corner of the mezzanine floor and running around the walls up to 259. Booths 260 to 282 run back and forth along the 46th St. side; 283 and 284 are near the front of the building on the 46th St. side, then numbers run crosswise of the building back and forth across the front. Booths 300 to 305 are found in front of the left-hand bank of elevators, 306 to 313 at the side of that same bank of elevators, 314 to 322 by the side of the right-hand bank of elevators, 323 to 331 in front of the right elevators and 332 to 347 run back and forth along the 47th St. side of the mezzanine floor.

Booths 401 to 575 are on the third floor, the numbering starting near the left rear corner of the floor and running around the walls up to 461. 462 to 476 run back and forth at the far side of the open court from stairs and elevators; 477 to 492 run back and forth on the 47th St. side of the court; 493 to 507 run back and forth in front of the court; 508 to 529 back and forth along the 46th St. side at the side of the court; 530 to 539 run back and forth at the head of the stairs; 550 to 553 are in front of the left-hand bank of elevators; 554 to 557 in front of the right bank of elevators; 558 to 569 run back and forth along the Lexington Ave. side of the floor; 570 to 575 are in the left rear corner along the wall.

On the fourth floor will be found booths 601 to 773, the numbering starting at the left in the rear and running around the walls up to 645. 646 to 733 will be found running back and forth lengthwise of the hall, starting near the 47th St. side and ending on the 46th St. side. The numbering 734 starts in the line of square spaces near 47th St. and runs crosswise back and forth at the head of the stairs up to 753, then 754 to 761 in front of the right bank of elevators and 766 to 773 in front of the left bank of elevators.

Grand Central Palace can conveniently be reached by means of the East side elevated or subway or by the Lexington Ave. surface line. For those coming from the West side of the city it can be reached by West side elevated with cross-over at 42nd St. The Palace is located on Lexington Ave. between 46th and 47th Sts. and within easy walking distance of the Grand Central Railroad Station.

Power Plant Engineering will be found in booth 99 on the main floor, where its representatives will be glad to be of service to visitors at all times, either in the matter of furnishing information, assisting in making appointments, or giving of help on power plant problems.

DIRECTORY OF EXHIBITS

ABSOLUTE CON-TAC-TOR CORP. Booths 478-490

Oil burner control system in operation. Temperature, pressure, heater and fan controls. Con-Tac-Tor mercury switches.

Representatives: H. F. Dever, advertising manager; P. W. Petersen, J. C. Bogle.

ACCURATE BRASS CASTING CO., INC. Booth 502

Brass and copper forgings and castings, to close dimensions.

Representative: Charles M. Rose, sales manager.

ACORN MFG. CO. Booth 768

Load indicator and communication systems.

Representatives: F. F. Elznic, sales manager; S. N. Mead, chief engineer.

ADVANCE ENGINEERING CO. Booths 274-6

Armstrong steam and air traps, Gast compressed air separators, Mosher steam and oil separators, Cadman blow-off valves and gate valves, Templeton pumping and return traps, Chicago-Wilcox gaskets.

Representatives: Charles W. Gill, C. Wilson Gill, Jr., Robert Bristow, A. S. Thomas, O. E. Ulrich for Armstrong Machine Wks., W. R. Templeton for Templeton Bros., Charles A. Saints for A. W. Cadman Co.; Mr. Temple for A. W. Cash Co., R. O. Monroe for Gast separators.

AEROFIN CORP. Booth 14A

Heating units for use singly or in bank with fin-tube surfaces and of non-corrodible material.

AIR PREHEATER CORP. Booths 234-5

Ljungstrom air preheater demonstrated by means of scene-in-action picture, models, photographs and drawings.

Representatives: Howard Butt, sales manager; C. A. Jacobson.

ALBAUGH-DOVER MFG. CO. Booth 674

Spur and worm gear reducers in operation and high grade cut gears. Ball and roller-bearing motor and speed reducer with speed ratio 800,000 to 1.

Representatives: F. G. Eppley, vice president; W. R. Schwab, chief engineer.

ALEXANDER BROS. Booth 625

Tentacular transmission belt demonstrated in actual operation.

Representatives: J. Allan Machin, sales manager; J. L. de Rabot, consulting engineer; Frank Barmes, sales engineer.

A. ALLAN & SON Booths 485-6

Application of Allan Red metal to pistons of internal combustion and steam engines, to air compressors, for the making of cored and solid bushings, for high pressure and high temperature globe valve discs and for packing rings for locomotive piston rods, valve stems and air pump rods.

Representatives: Andrew Allan, William T. Allan, Henry Chandler.

ALLEN & BILLMYRE CO., INC. Booths 491-2

Heavy duty industrial suction sweeping systems for power plants and factories in constant operation. Portable sweeping equipment for industrial service, centrifugal air turbo-blowers and exhausters.

Representatives: J. F. Billmyre, O. S. Lieberg, New York; L. B. Hard-

tla, Cleveland; I. E. Bickhart, Chicago.

ALLEN-SHERMAN-HOFF CO. Booth 75

Scene-in-action pictures showing the use of Hydrojet system of ash handling for removing ashes from beneath a water wall furnace, with hoppers and gates and also for discharge of ashes to a sump or for filling in vacant property.

Representatives: F. B. Allen, president; John T. Deutsch, D. W. Simler.

ALLIS-CHALMERS MFG. CO. Booths 516-8

Armorclad switch gear in operation showing combined unit bus bar construction, circuit breaker, feeder connections and instrument transformers. Roller bearing electric motors, models of hydraulic turbine runners for high and low heads; centrifugal pumps.

Representatives: A. E. Rolf, New York manager; H. W. Dennison, A. J. Cooper, R. H. James, C. A. Pihl, W. O. Taylor, L. M. Littman, F. M. Decker.

AMERICAN ABRASIVE METALS CO. Booths 730-1

Anti-slip walkway surfaces for stairs, platforms, floor plates and elevator thresholds. Feralun, Bronzalun and Alumalun will be exhibited.

Representative: Austin B. Sayre, vice president.

AMERICAN AIR-COOLED BLOCK-ARCH COMBUSTION CO., INC. Booth 567

Flat suspended air-cooled block arch for delivering preheated air to boiler furnaces.

Representatives: J. Francis Booraem, president and treasurer; E. J. Hatton, sales and erecting manager.

AMERICAN ARCH CO., INC. Booth 58

Improved type of unit supported furnace wall; air cooled wall; suspended arch.

Repesentatives: J. A. Lodwick, general manager industrial department; M. V. Kay, chief engineer; P. W. Antill, erection engineer; H. A. Mannsharot, New York; F. D. Hazen, Pittsburgh; E. Smiley, Philadelphia; J. J. Tyrrell, F. M. Willett, New England; W. B. Tardy, Baltimore.

AMERICAN BLOWER CO. Booths 319-22

Working models of the Sirocco flue dust collector and full sized exhibit of the collector for removing fly ash from the gases of powdered fuel plants.

Representatives: F. R. Still, vice president; C. T. Morse, general sales manager; Arthur Ritter, New York manager; E. W. Legier, New York; H. W. Pfeffer, manager, power apparatus division, Philadelphia.

AMERICAN BRASS CO. Booth 65

Sheets, wire, rods and tubes in copper, brass, bronze and nickel silver, also turbine blading, piston rods, bus bars, wire, cable and hollow conductors in brass, bronze and copper. Seamless connector for splicing wire and cables.

Representatives: H. B. Dwenger, D. A. Parker, H. A. Buckbee, T. M. Baker, A. C. Risedorf, W. H. Dowd.

AMERICAN CAR & FOUNDRY CO. Booth 201

Electric metal heaters for rivets, for upsetting and forging work and for long bars.

Representatives: F. C. Cheston, sales agent; W. M. Earl, J. S. Helt.

AMERICAN ENGINEERING CO. Booth 298

Lo-Hed electric hoists of pressed steel with ball bearings, push button control and for plain trolley, hook or lug suspension.

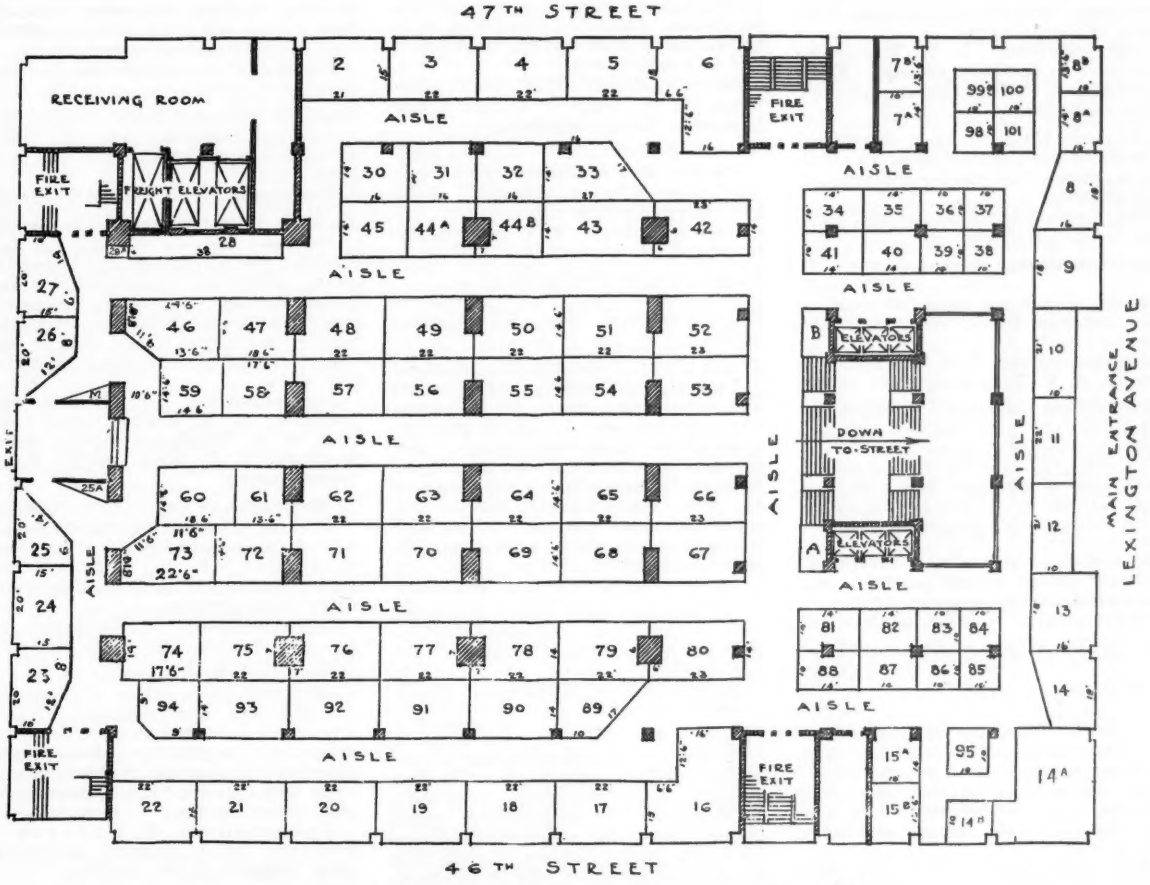


FIG. 1. PLAN OF BOOTHS ON FIRST FLOOR. NOS. 2 TO 101

AMERICAN FOUNDRY & EQUIPMENT CO. Booth 448

Special castings for high pressures and temperatures.

AMERICAN MACHINE & FOUNDRY CO. Booths 424-6

Automatic weighing machines for sacking materials; automatic continuous stream scales; oscillating lapping attachment; quick-acting chuck; Diesel and gas engines.

Representatives: J. D. McCarthy, advertising manager; W. B. Bronander, consulting engineer.

AMERICAN PIPE BENDING MACHINE CO., INC. Booths 770-1

Wonder pipe bending machines for making cold pipe bends.

Representative: J. M. Combs, advertising manager.

Representative: Edmond P. Blake, president.

AMERICAN SCHAEFFER & BUDENBERG CORP. Booth 74
Instruments for indicating, recording and controlling temperatures, pressures and speeds, including gages, safety and relief valves, traps, thermometers, temperature and pressure controllers.
Representative: G. A. Binz, general sales manager.

AMERICAN STEAM PACKING CO. Booth 666
Sheet and rod packings.

AMERICAN WELL WORKS Booth 662
Centrifugal and deep well pumping machinery, complete and in detail, with views of installations.
Representatives: R. W. Ruth, sales manager; G. H. Gaus, manager; E. H. Hendrickson, F. C. Hastings, Jr., New York office.

B. C. AMES CO. Booth 646
Machine tools including lathes, milling machines, fuel presses and micrometer gages.
Representatives: John Cetrule, Nicholas Cetrule, D. Seibel.

ANACONDA COPPER MINING CO. Booth 65
Brass, copper and nickel silver alloys for condenser tubes, rods, bars and wire.
Representatives: G. M. Hurlbut, C. A. Towles, F. F. Thursfield, L. D. Smith.

ANDALE ENGINEERING CO. Booth 214
Duplex oil and water strainers, steam strainers, oil coolers.
Representatives: D. Raymond McNeal, general manager; James M. Jenkins, C. R. Lind, Gilbert MacPhee, R. M. Norstrom, James T. Gordon.

ANDREWS-BRADSHAW CO. Booth 17
Tracyfiers in actual operation and disassembled to show construction.
Representative: J. Lucien Jones.

ARMSTRONG CORK & INSULATION CO. Booths 215-6
Thermal insulating materials including insulating brick for temperatures of 2500 deg., Nonpareil insulating brick for temperatures up to 1600 deg., high pressure covering, block and cement for high temperature steam lines, cork covering for refrigerated lines and corkboard for cold storage and building insulation.
Representatives: C. A. Center, sales engineer, New York; R. S. Broas, R. A. Wilson, W. T. Mathias, J. F. Isaacs, L. E. Cover, E. C. Lloyd.

ARMSTRONG MACHINE WORKS Booth 275
Traps for high-pressure and ordinary service. Demonstration of trap action by a glass model. Draining of water and oil from compressed air lines by traps.
Representative: O. E. Ulrich.

ASHTON VALVE CO. Booth 38
Pop, safety and relief valves, pressure and vacuum gages in indicating and recording type, dead-weight gage testers, high pressure and superheat safety valves and master pilot gages with double illuminated dials.
Representatives: Harry H. Ashton, sales manager; C. W. Buckelew, New York manager; C. W. Ulrick.

E. C. ATKINS & CO. Booth 631
Metal cutting machines in operation, including power-driven hacksaws and bandsaws, also hacksaw blades and small hand tools.
Representatives: E. W. Clark, New York manager; Edward S. Norvell, manager, metal cutting department; J. I. Kip, New England; A. H. Davis, New York; L. C. Garvin, Pennsylvania; Walter H. Sherer, New Jersey.

ATLANTIC GEAR WORKS Booth 626
Cast and cut gears.

ATLAS VALVE CO. Booth 612
Campbell boiler feed water regulator with positive regulation, fixed water level and ability to handle small volume, high capacity boilers. Reducing valves, damper regulators, temperature regulators, pump governors, float valves, swing joint fittings, thermostats and balanced valves.
Representatives: V. F. Davis, president; L. J. Siggins, secretary and treasurer; Grant Campbell.

ATWOOD & MORRILL CO. Booths 552-3
Turbine and condenser valves, special valves for low pressure bleeder heating and damper regulators.
Representatives: B. T. Atwood, secretary; J. H. Leggett.

BABBITT STEAM SPECIALTY CO. Booth 90
Chain-operated rims for overhead valves.

THE BABCOCK & WILCOX CO. Booth 54
Forged steel headers, drum nozzles and superheater boxes for pressures from 200 to 1450 lb. High pressure gage glasses and other fittings. Mechanical atomizing oil burner and oil burning furnace with special shapes of fire brick. Enduro and Toncan iron superheater and economizer tubes with test specimens which have been subjected to corrosive agents.
Representative: A. Ross Mackay.

E. B. BADGER & SONS CO. Booth 436
Corrugated type self-equalizing expansion joints, spray nozzles for cooling ponds.
Representatives: Frederick R. Heath, Frank E. Lyons.

BAILEY METER CO. Booth 51
Meter panel boards of various styles; Bailey Boiler meters, fluid meters, pressure and temperature recorders, tachometers and multi-pointer gages, Meter control for automatically regulating fuel and air supply in proportion to demand for steam will be in operation.
Representatives: E. G. Bailey, president; H. M. Hammond, sales manager; R. E. Woolley, H. C. Wheaton, H. C. Tanner, W. L. Paulison, Jr., H. Beaman, L. E. Evans, G. R. Avery.

BALLWOOD CO. Booth 346
Pipe fabrication of forged hammer welded flanged piping and Van Stone joints in sizes up to 6 in. for 600 lb. pressure.
Representatives: George A. Williams, A. H. Dirk, E. J. Hughes.

BARCO MANUFACTURING CO. Booth 515
Working models of balanced and lubricated plug valves for various services, also of flexible joints for pipe lines.
Representatives: Arthur S. Lewis, district sales manager; R. P. Klein.

BARNES & JONES Booths 312-3
Modulation, vapor and vacuum heating systems, radiator, vacuum return, boiler return and vent traps, modulation valves for steam and water systems.
Representatives: Walter E. Barnes, William T. Jones, Henry B. Eells, E. F. Sickenberger.

BARTLETT HAYWARD CO. Booth 529
Fast's flexible couplings, demonstrated by sectionalized models and photographs and showing the application to leading industrial operations.
Representatives: F. W. Thomas, H. C. Monroe, L. K. Thompson, Hugh Benet.

BAYER CO. Booth 347
Three models of mechanical soot blowers, showing balanced valve-in-head control and latest developments in high temperature elements.
Representative: Frederick P. Rose, New York office.

BEARINGS INDUSTRY CORP. Booth 482
Ball and roller bearings, the latter of taper and cylindrical type and steel balls.
Representative: S. Fabian Goodman.

BEARIUM BEARINGS, INC. Booth 524
Processed rods in all sizes and full lengths; special castings for Diesel engines, aeroplanes, machine tools and motor bearings; continuous demonstration of qualities of Bearium metal by running a bushing to red heat on cold rolled steel shaft and applying water and oil.
Representatives: H. M. Rees, vice president; G. H. Kendall, chief engineer; A. A. Matthews, eastern representative; J. E. King, middle states representative.

R. H. BEAUMONT CO. Booth 50
Working model in continuous operation of super-central coal and ash handling system with skip hoist, tram car, suspension bunker, larry, ash gates and cable drag scraper.
Representatives: R. H. Beaumont, Jr., Philadelphia; Mr. Ruth and Mr. Mosley, New York.

H. BELFIELD CO. Booth 673
Brass and iron expansion joints, screwed and flanged brass fittings, reducing and regulating valves, renewable disc globe valves, hydraulic valves, brass cocks, swing joints, water gages and copper fittings.
Representatives: W. Barnhurst, treasurer; H. L. Murray, secretary; John Newman, E. R. Goehring.

BERNITZ FURNACE APPLIANCE CO. Booth 78
Water wall equipped with Bernitz carborundum blocks and ventilated type of construction, using boiler furnace block.
Representatives: Arthur E. Smith, president and manager; E. R. Jefferson, H. C. Thayer, O. S. Carter, J. M. Nicholson, J. N. Macgowan, L. R. Leatherman, B. H. Snow, sales engineers.

BETHLEHEM STEEL CO. Booths 70-1
Bethlehem equipment including pulverizer in operation, Diesel engine, demonstration model of torque amplifier and back lash eliminator for amplification of power. Dahl oil burning system and Weir type boiler feed pumps. Charcoal iron boiler tubes.
Representatives: E. Newman, advertising department; J. P. Madden, machinery sales engineer; O. A. Kreutzberg, C. H. Johnson, engineers;

G. A. Worn, sales engineer; W. E. Dickey, L. M. Doyle, P. C. Tenant.

BIAX FLEXIBLE SHAFT CO. Booth 474
Operation of flexible shaft equipment, transmitting up to 5 hp. and showing various applications.
Representatives: R. Wezel, F. I. VanderBeek, Jr.

BIGELOW CO. Booth 68
Drawings and photographs of Bigelow-Hornsby water-tube boiler, Bigelow horizontal return tubular, two-pass, Bigelow-Manning and electric steam generator boilers.
Representatives: G. Welter, chief engineer; T. C. Vincent, G. W. Dahm, P. M. Fleming, M. A. Lyon, sales engineers.

L. C. BIGLOW & CO., INC. Booths 250-1
Ganschow planetary speed transformer and worm gear reducer, Wearever production tools, Whitney silent chain.
Representatives; L. C. Biglow, president; C. W. Derr, secretary; W. H. Beckwith, sales engineer; W. E. Simms, office manager; J. M. Carson, W. D. Faust, salesmen.

BLAW-KNOX CO. Booth 618
Dreadnaught clam shell buckets.

BOIG & HILL, INC. Booth 10
Curtis specialties, including regulators for pressure, temperature, water flow, damper control and steam traps.
Representatives: William T. Hill, Joseph Meyer.

BOILER ENGINEERING CO. Booth 450
Beco boiler baffle wall with expansion joint, using corrugated sheet metal separators, for horizontal or vertical water tube boilers.
Representatives: J. W. Putnam, Frank Beers.

BOND FOUNDRY & MACHINE CO. Booth 611
Truck casters in all designs for industrial and power plant use.
Representative: Martin M. Brown.

BORDEN CO. Booth 459
Demonstration of the operation of Beaver tools and power drives, also of No. 70 die stocks for use with the power drives.
Representatives: W. J. Clark, New England representative; A. J. Thornton, Pittsburgh; W. J. Mitchell, New York manager; Jack Seigrist, New York.

BOSTON GEAR WORKS SALES CO. Booths 340-2; 213-4
Standardized speed reducers of helical and worm gear types; standardized gears including hardened and ground spur gears; Renold-Boston silent and roller chain drives.
Representatives: H. H. Kerr, vice president; H. D. Woodsum, assistant manager; M. Schumb, engineering department; W. F. Weeks, development engineering department; W. E. Kerrish, advertising department; H. Muller, New York manager.

BOTFIELD REFRACTORIES CO. Booth 325
Adamant gun for applying refractory coatings and refractory materials, including fire brick and cement and Adachrome.
Representatives: L. B. Botfield, president; Axel H. Engstrom, sales manager; Charles C. Phillips, New York manager; A. J. Wittwer, W. B. Smith, Joseph J. Sweeney.

S. F. BOWSER & CO., INC. Booth 739
Filtration equipment for turbines and other prime movers including storing and dispensing units for main oil bearings; grease lubricator in actual operation for slow speed bearings and open gears; storage and dispensing equipment for lubricating oil; Xacto meter for fuel oil lines to burners and to underground tanks.
Representative: Mr. Kohler, sales manager of lubrication-filtration division.

BRADLEY WASHFOUNTAIN CO. Booth 247
54-in. white Marmorite washfountains with liquid soap dispenser.
Representative: A. C. Cooper, New York.

BRIDGEPORT BRASS CO. Booth 243
Brass, copper and bronze in sheet, rod, tube and special forms, also copper and brass pipe and pipe fittings.

BRISTOL CO. Booth 12
Recording and indicating instruments for pressure, temperature and liquid level; recording electrical instruments for voltage and current; recording tachometers; pyrometers for Diesel engine application.
Representatives: S. W. Case, St. Louis manager, in charge; C. W. Williamson, New York manager; H. T. Weeks, Denver manager; L. G. Bean, Chicago manager; R. S. Blodgett, H. L. Young, C. C. Mockridge.

BROWN INSTRUMENT CO. Booth 34
Large reproductions illustrating the widespread use of the electric flow meter, which operates on the induction bridge principle. Model of circular chart type to demonstrate outstanding features of this equipment. Indicating and recording model connected to manometer to illustrate operating principle and its sensitiveness. Automatic recording planimeter and integrator, indicating and recording pyrometers, CO_2 meters, gages, thermometers and tachometers.
Representatives: R. P. Brown, president; G. W. Keller, sales manager; M. M. Watkins, New York manager; G. Goodman, R. F. Roberts, H. L. Pfaffhausen.

BUFFALO FORGE CO. Booth 2
Mechanical draft apparatus for forced and induced draft; ventilating fans and system of generator cooling.
Representatives: C. A. Booth, vice president and general sales manager; F. B. Stubinger, advertising manager; O. S. Ryan, service department; R. W. Pryor, W. H. Koithan, New York.

BUFFALO STEAM PUMP CO. Booth 73
Boiler feed pump; ball bearing pump; non-clogging sewage pump; special plant equipment.
Representatives: A. G. Peterson, sales manager; F. B. Stubinger, advertising manager; O. S. Ryan, service department; R. W. Pryor, W. S. Koithan, New York.

BUILDERS IRON FOUNDRY Booth 277
Venturi meter for measurement of boiler feed supply and steam; shunt steam meters to measure economically the flow of steam in small pipe lines.
Representatives: Mr. Richardson, Mr. Bartlett, Mr. Wood, Mr. Purdie, Mr. Connet, Mr. Watjen, Mr. Dolbey, Mr. Skerry, Mr. Hammond.

BUNDY STEAM TRAP CO. Booth 8
Bundy traps, entire line for various power plant conditions with details of construction.
Representatives: Everett M. Stevens, vice president and general manager; W. W. Booth, New York; D. J. Stump, Boston; J. E. Fulweiler, Philadelphia.

EDWIN BURHORN CO. Booth A
Burhorn cooling towers including a model in operation and the use of these towers for Diesel engine and air compressor cooling water and in refrigerating plants.
Representative: Edwin Burhorn.

A. M. BYERS CO. Booths 442-3
Van Stoned joints in genuine wrought iron pipe, special red stripe marking, examples of resistance of wrought iron pipe to corrosion under severe conditions.
Representatives: H. L. Chute, Lee Turner, R. W. Law, Fletcher Collins, G. W. Hamill.

ANDREW C. CAMPBELL, INC. Booth 660
Nibbling machines in operation, making special shapes from metal plate.
Representatives: Stuart Narramore, sales manager, J. Johnson.

CARBORUNDUM CO. Booth 22
Water tube side wall of Carbofrax refractory, Carbofrax, Aloxite and Infrax brick and shapes for high temperature industrial furnaces; Carbofrax air-cooled blocks.
Representatives: C. E. Hawke, sales manager; S. A. Fenno, assistant sales manager; J. A. King, New England; F. W. Miller, New York; J. G. Fritzinger, Philadelphia.

CARR FASTENER CO., DOT LUBRICATING DIVISION Booth 744
System and devices for lubricating industrial machinery, including Dot guns and nipples, pressure cups, centralized system and lubricating tank. Method for analyzing plant requirements and arranging complete lubricating system.
Representatives: Charles L. Hall, New York manager; A. W. Smith, factory representative.

CARRICK ENGINEERING CO. Booth 295
Control for automatic regulation of combustion in boiler furnaces, electric and hydraulic operated types.
Representative: M. I. Finnegan.

CARRIER ENGINEERING CO. Booth 14-A
Heating and ventilating equipment with air-conditioning apparatus and generator cooling system.
Representative: W. H. Carrier.

CASEY-HEDGES CO. Booth 343
Working model of multi-pass boiler, with description and illustration of other types of boilers and samples showing construction of heavy plate work.
Representatives: L. H. McGowan, D. J. Roland, H. J. Marks.

A. W. CASH CO. Booths 276, 28
Craig system of combustion control and models of pressure regulating devices and stock valves.
Representatives: C. W. Court, V. A. McKechnie.

CELITE PRODUCTS CO. Booth 14
Demonstration of difference in heat transmission between insulated and partially uninsulated furnace wall; Sil-O-Cel brick, powder, cement and block, also C-3 aggregate for making insulating concrete.
Representatives: E. S. Crosby, general sales manager; F. H. Emerson, division sales manager; A. L. Gossman, assistant division sales manager; Wm. D. Van Arnam, New York manager;

Fred Horine, sales engineer; P. R. Deschere, G. F. Habekotte, L. E. Putnam, salesmen.

CENTRIFIX CORP. Booths 302-3

Purifiers and live steam separators for steam, air, gas and vapors.

Representatives: L. C. Kerner, Geo. von Haase, S. B. Whinery, Edwin A. Knowlton.

CENTURY ELECTRIC CO. Booths 712-3

Century automatic starting 2 and 3-phase induction motors.

Representatives: James Larkin, New York manager; E. W. Pritchard, J. A. Craig, A. Mandel.

CHAPMAN VALVE MFG. CO. Booth 2

Chrome nickel steel gate valves for high pressure and high temperature work, working model of improved Chapman motor unit.

Representatives: George E. Fox, chief engineer; James H. Wahl, electrical engineer; Thomas F. Maher, manager of sales; V. T. Malcolm, metallurgist; Ernest Cochran, New York manager.

CHICAGO CHEMICAL CO. Booth 693

Testing and treating methods for use of K. W. S. sodium aluminate both directly in the boiler and in conjunction with lime and soda ash.

Representatives: A. E. Warner, sales manager; F. H. Thorne, field manager of sales and service; Arthur Fromel, New York; W. F. Nichol, Philadelphia.

CHICAGO PIPE THREAD MACHINE CO. Booth 472

High speed precision pipe threading machine, power driven.

Representatives: Leslie H. Taylor, president; R. T. Ingalls, secretary; C. Peterson, treasurer.

CHICAGO PUMP CO. Booths 636-9

Duplex set of Flush Kleen sewage ejectors in operation with automatically cleaned screen; new condensation and vacuum pump known as Condo-Vac of special interest to heating engineers; horizontal centrifugal pumps; standard Underwriters' fire pump complete.

Representatives: M. I. Weil, president; G. F. Mannion, manager of sales; D. M. Allen, F. E. Lewin, A. D. Baynes, New York.

CHICAGO WILCOX CO. Booth 274

U-shaped metal gaskets with asbestos, rubber or leather filling.

Representatives: Mr. Dawson, William F. Kall.

COCHRANE CORP. Booth 67

Hot water softening process, including conical strainerless filter and chemical proportioner with agitating apparatus; flow meter for water, steam, air and other fluids; deaerating heater and vent condenser; steam and oil separators; high pressure trap and low pressure drainer; multiport valve.

Representatives; J. C. Jones, general manager; H. E. Sibson, general sales manager; A. B. Wallem, general works manager; J. D. Yoder, manager softener department; P. S. Lyon, chief engineer; J. E. Harris, general sales; W. Sailer, manager trap and drainer department; C. E. Joos, manager steam purifier department; E. S. Daugherty, manager steam flow meter department; A. R. Foote, F. B. Sage, W. W. Montalvo, New York; C. B. White, Chicago; E. Green, Boston; H. B. Mann, Pittsburgh.

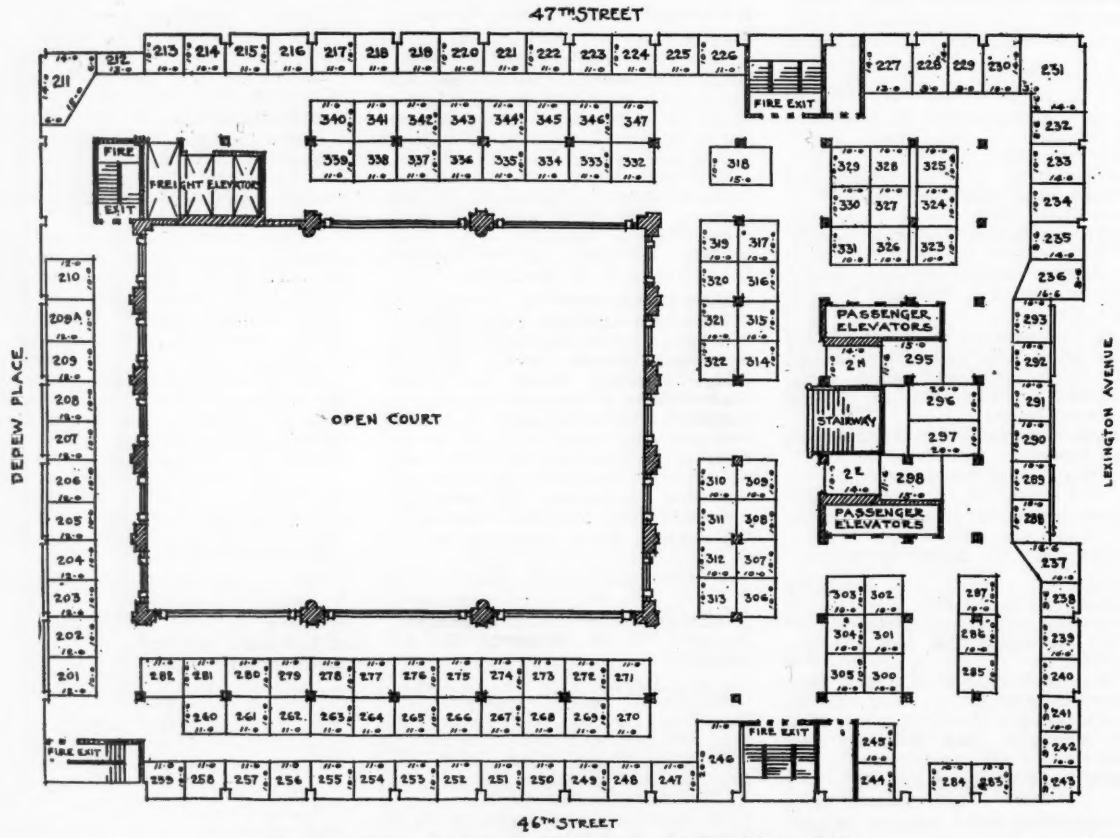


FIG. 2. SECOND OR MEZZANINE FLOOR. BOOTHS 201 TO 347

CLARAGE FAN CO. Booths 245-6

Clarage humidifier and Clarage unit heater, the humidifier of new design adapted for small installations.

Representatives: Mr. Clarage, Mr. Monroe, Kalamazoo; Mr. Smith, Mr. Anderson, Mr. Wasson, New York; Mr. Robinson, Philadelphia.

CLEMENTS MFG. CO. Booth 773

Portable electric blower and vacuum cleaner unit.

Representatives: W. J. Clements, vice president; J. W. Stokes, sales manager, blower division; R. M. Sitterley, foreign sales manager; W. H. Cline, New York.

CLIPPER BELT LACER CO. Booth 551

Clipper belt lacers, belt lacing and cutting equipment, speed lacer, electric clipper ship model in action.

COEN CO., INC. Booth 15-B

Oil burning equipment, including burners, registers and oil heaters.

Representative: F. F. Harper.

COFFIN VALVE CO. Booths 408-9

Kelty motor drive unit operating 10-in. gate valve; automatic solenoid operated hydraulic cylinder and valve; solenoid operation of hydraulic cylinder for remote control.

Representatives: C. R. Kelty, F. W. Anderson.

COMBUSTION SALES CO., INC. Booth 728
Furnace fire observation window.
Representative: L. E. Anderson.

COMBUSTION SERVICE CORP.
Booths 716-7; 732-3
Combination burners for coal, oil or gas with special air control, in capacities from 200 to 4000 lb. of pulverized coal per hour per burner.

COMPRESSED SPRUCE PRODUCTS CO., INC.
Booth 695
Complete line of pulleys for power transmission; rolls, wheels, non-metallic gears and pinions, blocks for absorption of noise and vibration.
Representatives: L. J. Ollesheimer, R. L. Watts, A. W. Gelpcke, F. R. Andrews.

CONNERY & CO., INC. Booth 43
Connery's expansion stiffener, air-cooled damper, expansion stack connection and covering attachment for use in connection with breechings, uptakes, air and preheater ducts.
Representatives: William M. Connery, president; E. C. Aucott, secretary; A. D. Stewart, W. J. Henderson, C. B. Nicholson.

CONSOLIDATED GAS CO. OF NEW YORK
Booth 613
Combined exhibit of gas companies of Brooklyn, Kings County, Manhattan and Staten Island to demonstrate uses of gas for industrial processes.
Representatives: George Stang, sales manager, Brooklyn Boro Gas Co.; R. J. Stanniford, Jr., T. P. Merkt, Jr., J. F. Quinn, J. Jaros, Brooklyn Union Gas Co.; A. J. Peters, C. E. Muehlberg, A. M. Apmann, Consolidated Gas Co.; W. A. Morris, Kings County Lighting Co.; George Smith, S. Reiter, New York and Richmond Gas Co.

CONSULTING ENGINEERING CO.
Booth 665
Northwestern combustion control systems electrically operated for control of coal, gas or pulverized fuel fired boilers, to maintain constant steam pressure, constant draft over fire and regulate the feed of fuel.
Representative: T. G. McCann, president.

CONTINENTAL VALVE & EQUIPMENT CO.
Booth 316
Framanco governors and reducing valves, forged steel screw end fittings, forged steel box and flange unions, flanged fittings and hydraulic fittings.
Representatives: Olaf E. Oleson, president; William T. Shea, vice-president.

COOK ELECTRIC CO. Booth 710
Metal bellows of monel, bronze or brass, automatic fuel oil pumps, oil regulating devices, anti-syphon valves and gages, low pressure gages, air regulating valves, furnace damper regulators, automatic steam valves, traps, flexible couplings, heat motors and heat coil protectors.
Representatives: Geo. R. Folds, president; L. M. Persons, D. C. McKee, E. D. Swanberg, J. F. Jaap.

COOPER HEWITT ELECTRIC CO. Booth 504
Mercury vapor lighting as applied in the industrial field, also Cooper Hewitt Kon-nec-tors for making and breaking electric circuits.
Representatives: Chas. F. Strebig, D. R. Grandy, J. P. O'Shea, A. H. Kuehne, A. W. Willmann, W. C. Hubbard, H. M. Ferree.

CORK FOUNDATION CO., INC.
Booths 760-1
Absorbo cork foundation mats for absorbing vibration of machinery.
Representatives: W. F. Timmis, J. W. Clissold, William Karl, Dore Sundland.

CHAS. CORY & SON, INC. Booths 241-2
Electrical equipment, Robinson interlocks, signal and alarm systems, electric wiring appliances and fixtures, switchboard equipment.
Representatives: J. M. Cory, J. S Jones, L. E. Oneal, A. D. Blanchard, J. Waldman, J. Harper, Sr., J. B. Feder, A. A. Kopp, C. B. Hale, F. W. Wood, R. L. Casson, G. B. Thieme, W. Maynes, G. M. Marr, H. Gelbarth, M. I. Warshaw, H. Schelhammer, O. McMurray.

CRANDALL PACKING CO. Booth 755
Raw materials, manufacturing processes and finished products for rod and sheet packings made from asbestos, duck and rubber, flax and metallic packing.
Representatives: O. W. Wagner, director of sales; Robert Wagner, New York branch manager.

CRANE CO. Booths 52; 462-4
Valves and fittings of brass, bronze, cast iron, ferrosteel, cast steel and forged steel of various weights to cover the full range of pressures and temperatures encountered in general service. Section of large size steel gate valve.
Representatives: M. Baxter, Chicago; G. E. Barker, New York.

CROSBY STEAM GAGE & VALVE CO.
Booth 98
Nozzle type safety valves for pressures up to 1500 lb.; new tool for reseating of safety valves on boiler; gage board exhibit including lathe turned, screwed tube steam gage and fullway blow-off valve.
Representatives: George F. Felker, vice president; A. W. Lenderoth, M. F. Murphy, Jr.

CROUSE-HINDS CO. Booth 610
Conduit for electric wires and new Obround condulets.

CUTLER-HAMMER MFG. CO. Booths 454-5
Motor starting equipment both hand and automatic in operation for direct and for alternating current. Also overload relays and shields for heavy arcs.

CUTTER ELECTRICAL & MFG. CO.
Booth 740
40,000-amp. air break circuit breaker, non-closable on overload or short circuit. 1000-amp., 3-pole, double-throw automatic transfer switch. U-Re-Lites enclosed in steel box for circuit protection.
Representatives: E. Swift Newton general manager; W. C. Jessup, R. C. Heyl, Max B. Cutting.

DAMPNEY CO. OF AMERICA Booth 248
Apexior protective coatings for metal surfaces and apparatus for application to boiler and economizer tubes. Samples of coated tubes after various lengths of operating service.
Representatives: E. F. Gilbert, president; C. F. Moore, J. S. Cheverie, Boston; T. H. Burch, Jr., P. L. Rhodes, New York; C. J. Hunter, Philadelphia; B. M. Herr, Pittsburgh; D. H. Skeen, D. S. Walker, Chicago; A. T. Hunter, St. Louis; A. MacLachlan, Cleveland.

M. T. DAVIDSON CO. Booths 36-7
Steam and centrifugal pumps of simplex light and heavy duty type and of single and multiple stage design. Also vertical submerged sump pump.
Representatives: John Lowe, W. C. Newell, Thomas J. Rogers, William E. Brennan, Harry A. Prindle.

DAVIS ENGINEERING CORP.
Booths 415-6
Paracoil products, including feed water heaters, evaporators, distillers, oil coolers, feed water filters and grease extractors, water heaters of storage and instantaneous type, steam traps.
Representatives: C. G. Smith, sales manager; H. C. Davis, W. H. Thompson, R. W. Brown, W. W. Young, A. O. Jaeckel.

G. M. DAVIS REGULATOR CO. Booth 267
Pressure regulation, control and relief equipment, non-return valves, traps and wing disc valves for use as check valves.
Representatives: George C. Davis, president; Herb Freeman, New York manager; Ed Brock, Boston.

DEARBORN CHEMICAL CO. Booth 13
Dearborn method of treating boiler feed water; No-Ox-Id rust preventive and information on lubricating oils and greases.
Representatives: Herbert J. Cornell, New York manager; Mr. Spear, Mr. Kinney, Mr. Rensen, Mr. Harris.

DE BOTHEZAT IMPELLER CO., INC.
Booth 769
Industrial, forced draft, high-pressure and ventilating disc fans with demonstration of high static pressure.
Representatives: A. G. Nichols, assistant general manager; R. F. Ruggles assistant sales manager.

DELAVAL SEPARATOR CO. Booths 536-9
Oil reclamation equipment, including crank case oil reclaiming outfit, turbine oil purifier and special type horizontal purifier. Illustration of steam turbine piped with oil purifier equipment, including pump and sight glass.
Representatives: P. F. Miller, D. F. Miller, J. H. Lisle, C. B. Bower, S. W. Moss, W. D. Cleary, A. J. Marron, R. L. Smith.

DELAVAL STEAM TURBINE CO.
Booths 540-3
Centrifugal pump specially developed for feeding modern high pressure boilers, with split diaphragms and metal to metal joints. Labyrinth wearing rings and hydraulic balancing of end thrust.
Representatives: C. R. Waller, chief turbine engineer; A. Peterson, centrifugal pump and compressor engineer; H. J. Kilroy, sales department; J. W. Hertzler, manager worm reduction gear department.

DELAVERGNE MACHINE CO. Booth 760
Diesel engines of solid injection type; ammonia compressors, condensers and raw water ice system.

JULIAN D'ESTE CO. Booth 10
Curtis Engineering specialties, including pressure regulators for steam, air, gas and water, temperature and damper regulators and various types of steam traps.
Representatives: D. A. Herrick, George Bezanson.

DETROIT STOKER CO. Booths 203-5
Operation of Detroit stoker with

multiple retort design for underfeed practice.

Representatives: W. H. Rea, president; W. H. Riecks, secretary; R. L. Beers, chief engineer; H. B. Post, New York manager; H. W. Maitland, service department; Robert June.

M. H. DETRICK CO. Booth 94

Full size model of Detrick arch and sectionally-supported air-cooled type wall. Blueprints and cuts of installations and of furnace designs for stokers and pulverized fuel plants.

Representative: R. D. Foltz, vice president.

DEWATERS SAFETY LATCH CO. Booth 263

Models on stands and mounted on boiler ring doors as in practice to demonstrate the effective operation of the device.

Representatives: L. A. DeWaters, president; C. W. Obert, vice president.

DIAMOND POWER SPECIALTY CORP. Booths 16-17

Complete equipment of soot blowers and elements, with hand and automatically operated valves and demonstration of the formation and removal of soot and ash deposits.

Representatives: N. L. Snow, president; W. P. Thomas, secretary; J. E. Heeter, Philadelphia; G. L. Davis, W. P. Thomas, Robert June, Detroit; H. W. Gilson, C. R. Vincent, L. W. Nones, New York; B. H. Hill, Pittsburgh.

WALTER S. DICKSON CO. Booths 232-3

Specialties for the control and operation of heating systems.

Representatives: E. B. Sanders, R. B. Kleinert.

JOS. DIXON CRUCIBLE CO. Booth 254

Graphite and graphite greases, graphite paints, pipe compounds and other lubricating and protective products.

Representatives: J. M. Willits, Cameron MacNaughton, O. D. Shonnard, C. A. Williamson, J. W. Caldwell, Harvey Regan, John Georg, Joseph Drayton.

DODGE MFG. CO. Booths 465-70

Power Transmission equipment, including split pulleys with wood bushings, hangers, shafting and rope drive equipment.

Representatives: A. P. Strong, H. T. Robbins, T. H. Upson, W. W. Dodge.

DRAKE NON-CLINKERING FURNACE BLOCK CO. Booths 227-8

S. X. air-cooled wall in fire clay, also Armor Clad water wall and Drake power burner for pulverized fuel.

Representative: S. M. Finn, general manager.

C. A. DUNHAM CO. Booths 701-2

Working units of series pump, differential vacuum pump, condensation pump and receiver; thermostatic radiator traps, float and thermostatic return traps, air eliminators, packless radiator valves, low-pressure reducing valves, showing interior mechanism of all equipment.

Representatives: C. A. Dunham, president; Oliver J. Prentice, manager.

DURABLA MFG. CO. Booth 236

Durabla products including pump valves, sheet packing, cut gaskets, rod packing, gage glasses and washers.

Representatives: G. F. Marriott, H. M. Wilson, E. A. Starks, J. George Wholey, W. R. LeFevre, S. T. Hiatt, W. A. Doran.

DURAMETALLIC CORP. Booth 749

Metallic packing in spiral, molded ring, wedge and tapered ring form. Plastic semi-metallic packing.

Representative: C. C. Hall, vice president.

EASTERN STEAM SPECIALTY CO., INC. Booth 440

Instant water heater equipment, flow indicator for vertical or horizontal lines.

Representative: R. Palmer.

ECONOMY PUMPING MACHINERY CO. Booth 471

Centrifugal pumps of improved design, including double-suction, horizontal, split-case types, heavy-duty, multistage horizontal type, automatic condensation pumps and receivers, centrifugal vacuum pumps and caisson pump for high head.

Representatives: R. H. Thomas, president; H. R. Ryan, sales manager; G. J. Rowland, W. E. Burns, E. S. Quackenbush, New York office.

EDGE MOOR IRON CO. Booths 288-90

Full size hammer-welded boiler drum illustrating a new departure in American boiler practice, for single-pass boiler. Drawings and photographs of recent installations of longitudinal and cross drum boilers, also single-pass waste heat and heating boilers.

Representatives: Wm. Bradford, A. D. Flower, W. Greacen, engineering department; S. G. Bradford, J. F. Glenn, H. M. Lodge, A. L. Tyre, Jr., H. C. Evans, G. B. Clark, W. L. Ford, W. G. Crichton, sales department.

EDWARD VALVE & MFG. CO. Booth 30

Forged steel globe valves in 2 in. and smaller for pressures up to 900 lb., also larger valves showing the high pressure cast steel and Ferac line.

Representatives: J. E. McDonald, sales manager; J. R. Goodwin, New York.

ELLIOTT CO. Booths 271-3

Special feature will be a new type turbine-driven centrifugal blower of single inlet, single stage, overhung construction with cast iron casing and aluminum alloy impeller. Other Elliott products, including steam turbines, engines, motors, ejectors, deaerators, feed heaters, strainers, valves and boiler tube cleaners will be shown by photographs.

Representatives: H. A. Pastre, special representative; J. E. Watson, general manager; W. E. Widau, condenser sales manager; C. W. Kalbfus, advertising manager; B. G. Fernald, New York manager; H. L. Freas, H. R. Bushley, R. H. Gaither, A. W. Eddy, R. N. Tilley, Carl Schmidt, H. V. Allen, New York; P. E. Good, manager; and A. L. Bromiley, blower department.

LEWIS M. ELLISON Booth 44B

Ellison draft gages and steam calorimeters, including straight-line and pointer gages.

Representatives: Lewis M. Ellison, Henning L. Hultman, Joseph W. Eshelman.

CHARLES ENGELHARD, INC. Booth 675

Measuring and recording instruments for temperatures of heaters, condensers, economizers and gases.

Representatives: H. deGallaix, field manager; E. G. Pierce, A. C. Schmid, district managers; J. H. Oetjen, factory engineer.

ENGINEER CO. Booth 18

Enco combustion control, steam pressure regulator, damper regulator, models of oil and gas burner baffles for horizontal and vertical boilers and a combination of cross baffles with back arch system for chain grate stokers.

Representative: A. W. Patterson, Jr., vice-president.

ERIE CITY IRON WORKS Booths 221-2

Three-drum inclined water-tube boiler with integral economizer and water cooled furnace, also details of the Unitype pulverizer for powdered coal feeding and of the construction of the Seymour furnace.

Representative: G. D. Selden.

ERNST & CO. Booth 76

Water columns and gage glass equipment.

EVERLASTING VALVE CO. Booths 100-1

Blow-off valves in angle, disc, duplex and tandem types for pressures from 250 to 600 lb. and in sizes from ¼ in. to 6 in. Improved-disc-spring type for medium pressures.

Representatives: George M. Elton, Jr., in charge; John H. Allen, president; Wylie G. Wilson, engineer; E. N. Corning, S. E. Carman, Edward Boll, sales engineers.

EX-CELL-O TOOL & MFG. CO. Booth 664

Precision parts for Diesel engines, including injection pumps and injection spray nozzles; also drill jig bushings and internal grinder spindles.

Representative: F. D. Sicklesteel, assistant sales manager.

FAFNIR BEARING CO. Booth 246

Ball bearing transmission equipment, including hanger boxes, pillow blocks, blower boxes, standard ball bearings of single and double row type and for thrust. Ball bearing exhibit in operation to demonstrate the small amount of power used in such bearings.

Representatives: R. N. Hemenway, manager industrial division; C. F. Stanley, assistant manager; H. R. Reynolds, chief engineer; Thomas Reilly, George Barenborg, D. J. Gilbert, sales engineers.

FAIRBANKS, MORSE & CO. Booths 326-31

Diesel engine generating set, sectionalized squirrel cage and enclosed self-ventilated type motors, centrifugal, ball bearing and other centrifugal and power pumps for high speed and high head.

Representatives: G. H. Jernberg, A. C. Dodge, T. W. Drennen, G. S. Thompson, T. R. Norton, T. D. Slingman, Sr., T. D. Slingman, Jr., C. A. Sticht, H. P. Miller, H. G. Harper, W. C. James.

FALK CORP. Booths 338-9

Herringbone gears and speed reducers, flexible couplings and motor-driven pump with flexible coupling showing the ability to handle misalinement and freedom of endfloat.

Representatives: Mason Hulett, M. A. Carpenter, advertising manager; M. P. Fillingham, E. A. LeMay.

FARNSWORTH CO. Booth 605

Drainage receiver and pump for metering high temperature liquids and recording temperature. Steam specialties to effect heat reclamation and save fuel.

Representatives: F. C. Farnsworth, president and general manager; George Onfrey, production manager; J. B. Tucker, assistant production manager.

FEDERAL GAGE CO. Booths 535, 544

Gages for pressure and vacuum or indicating and recording type Mercoid switches with motor control by means of temperature and pressure changes.

FISHER GOVERNOR CO., INC. Booth 35

Fisher power plant specialties, including pump governors, reducing valves, steam traps, float valves and liquid level controllers for both direct connection and remote control.

Representatives: L. W. Browne, vice-president; O. M. Galliher.

FLEXIBLE STEEL LACING CO. Booth 547

Steel belt lacing, belt fasteners and guards for electric lamps.

Representatives: H. L. Reinhorn, C. L. Garesche.

gear reduction units of spur, worm and herringbone type, also combination units with reduction of 1500 to 1.

Representatives: J. R. Shays, manager; M. Granich, New York.

FOSTER ENGINEERING CO. Booth 84

Foster automatic valves of drop forged cast steel chrome construction for high boiler pressures and temperatures; pressure reducing regulators and pump governors; Foster sight flow box, Foster flexible ball joint.

Representatives: C. A. Olson, president and general manager; C. R. Emerson, vice-president and sales manager; W. E. Heck, assistant sales manager; George E. Breece, New Jersey; Henry J. Fortier, New York; James D. Ros-

Kenney, J. W. Lea, W. L. Martwick, J. J. Nelis, F. G. Page, C. F. Parker, D. D. Pendleton, J. A. Potter, L. M. Rakestraw, H. N. Reiche, H. L. Robinson, C. Russell, J. K. Seabright, J. H. Sengstaken, F. D. Seymour, R. D. Spear, F. J. Swenson, G. G. Van Tuyl, P. N. Wenz, G. Parsons West, H. W. Wetjen, T. H. Wilkins, R. H. Wyld.

FOUNDATION CO. Booths 296-7

Illustrations of steam and hydroelectric plants constructed by the company with details and methods of construction used.

Representative: Colonel F. W. Lewis.

FOXBORO CO., INC. Booth 62

Indicating and recording thermometers and pressure gages, draft gages,

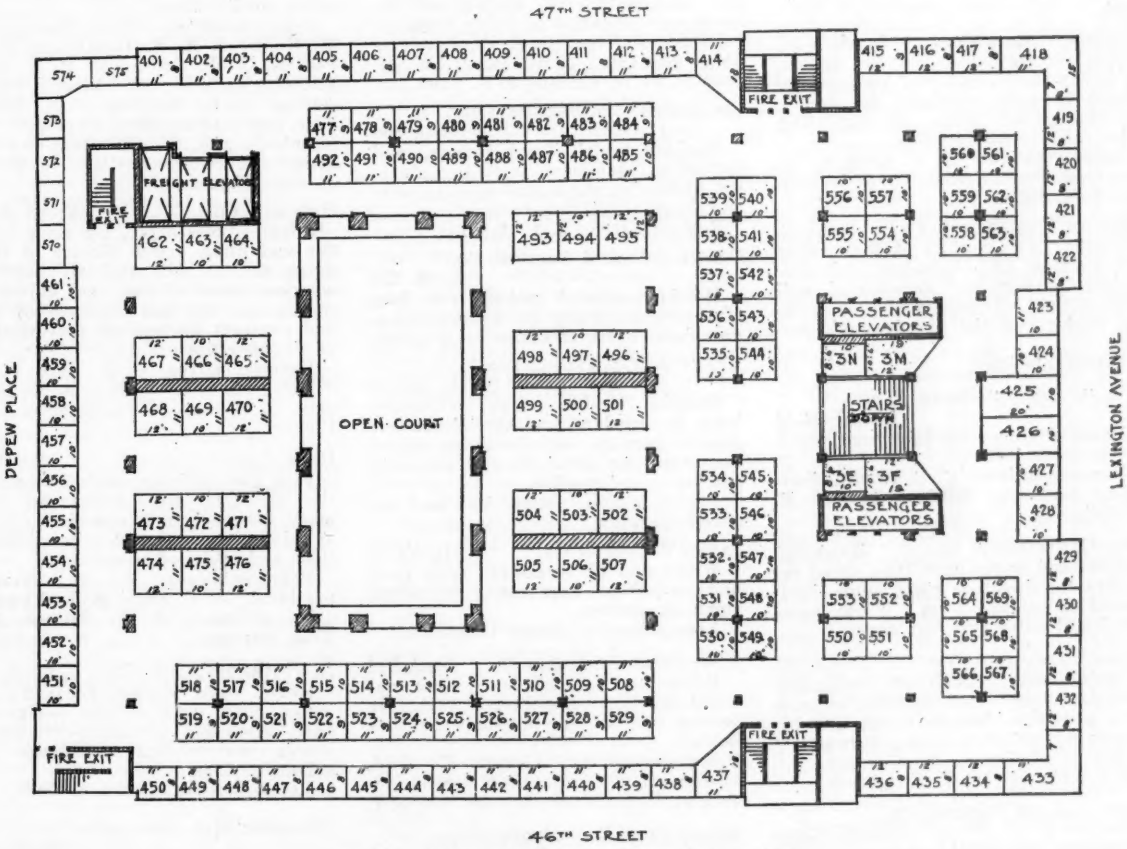


FIG. 3. THIRD FLOOR HAS BOOTHS 401 TO 575

FLYNN AND EMRICH CO. Booth 46

Complete three section Huber mechanical stoker in working operation, to show the exact course of the fuel through the stoker and its action.

Representatives: Henry H. Hyde, sales manager; James F. Turner, Charles J. Huber, Baltimore, Md.; D. T. Dobyns, New York; A. E. Miller, J. Fred Weller, Harold G. Green, Newark, N. J.; Carl Smerling, Franklin, Pa.; Ward C. Tooke, W. Warren, Pa.; Damiel Smerling, New Haven, Conn.; Edward Forsythe, F. H. Forsythe, Philadelphia, Pa.; Myron E. Whitham, Rochester, N. Y.; A. E. Smith, E. B. Allen, H. P. Curtiss, Allen Engineering Sales Co., Boston, Mass.

FOOTE BROS. GEAR & MACHINE CO. Booth 550

Display of vertical and horizontal

tron, Philadelphia manager; William E. Ward, special representative; W. R. Ladewig, Los Angeles; Elmer W. Johnson, Chicago manager; G. Emerson Taylor, Philadelphia.

FOSTER WHEELER CORP. Booths 20, 64

Full size sections of Foster apparatus, including sectional air heaters, economizers, superheaters, water-cooled furnace surface, Foster water back, and tubular oil still elements. Drawings and photographs of Wheeler condensers, pumps, cooling towers, evaporators, feed water heaters, steam jet vacuum pump; Crescent brand brass and copper tubing.

Representatives: H. B. Baird, J. B. Bell, Jr., P. T. Buckler, T. C. Craig, D. K. Dean, Arno N. Dietze, F. A. Faville, Geo. B. Ferrier, P. W. Foster, Jr., E. R. Goodrich, J. Healy, J. E.

boiler level gages, tachometers, flue gas recorders and standard power plant instruments.

Representatives: W. W. Patrick, New York district manager; C. C. Fuller, K. L. Barton, L. L. Tremaine, F. M. Laird.

O. E. FRANK HEATER & ENGINEERING CO. Booth 657

Heat exchanger with split shell to give access to the exterior of all tubes; U-tube storage type heater.

Representatives: Mrs. Olive E. Frank, president; Herbert P. Wilder, F. A. Hodge, Jr.

FREDERICK IRON & STEEL CO. Booths 405-6

Operating centrifugal pump to show visibly the impeller action. High-pressure centrifugal pump for boiler

feed. Operation of revolving roll separator in sizing and separating coal, from mine tipple to loaded cars.

Representatives: G. R. Hargis, chief engineer; A. L. Brice, J. T. Norman, coal separator dept.; J. J. Conway, New York manager.

FULLER LEHIGH CO. Booth 54

Coal pulverizing and feeding equipment, pulverized fuel burners, equipment for transporting pulverized fuel, waste heat dryers and water-cooled furnace walls. Drawings of installations.

Representatives: E. G. Bailey, president; E. J. Billings, vice-president in charge of sales; E. H. Fromm, secretary and treasurer; J. B. Gaffney, chief engineer; L. W. Heller, assistant chief engineer; R. A. Hawk, in charge of booth.

FULTON-SYLPHON CO. Booth 252-3

Temperature regulators for liquids, air in dry rooms, high and low pressure steam; pressure regulator for steam, air and gases; safety oil regulating valve for oil fired boilers.

Representatives: A. W. King, A. W. Shepherd, F. C. Reeder, H. A. McDonald, G. M. Ellis.

FURNACE ENGINEERING CO. Booth 41

Simplex unit system of pulverizing and burning fuel, including unit pulverizer, burners and armor clad wall construction. Animated picture showing working of the Simplex unit system.

Representatives:

G. & G. ATLAS SYSTEMS, INC. Booths 86-88

Pneumatic dispatch tubes and power saving control valve.

Representatives: C. E. Prout, advertising manager; William Dinspel, E. Weigele.

WM. GANSCHOW & CO. Booth 750

Spur and worm gear type speed reducers for direct or right angle, horizontal or vertical form. Worm, spur, bevel and miter type cut gears.

GARDEN CITY FAN CO. Booth 685

Multiblade, motor-driven ventilating fan, direct connected propeller exhaust fan, pressure blowers, exhausters for conveying materials, and unit heater.

Representatives: W. Gardner, Jr., sales manager; W. T. Wrightson.

THE GARLOCK PACKING CO. Booths 545-6

Quality controlled mechanical packings with working model showing the use of oil return metal packing, air and gas compressor packing, condenser tube packing and cord plugs for cleaning condenser tubes will be exhibited in a booth decorated in a wall color scheme of maroon, velour curtains with black valances and rugs in gold and black.

Representatives: F. P. Morton, J. J. McLaughlin, Joseph Yamin, C. R. McAfee, Isaac McAllister, C. D. Castle, J. H. Reyelt, J. M. Drinkwater, H. O. J Garlock.

GENERAL ELECTRIC CO. Booths 4, 5

Motors and control, a centrifugal air compressor, a small automatic turbine battery charging equipment and atomic hydrogen welding. The welding exhibit will show welding of various alloys and non-ferrous metals, also thin metal and production of ductile welds. Steam turbines will be exhibited of the types used for driving pumps, air compressors and small generators with sections of the turbine cut away to show interior construction and methods of varying the speed over a range of 6 to 1.

Representative: C. T. McLoughlin.

GENERAL REFRACTORIES CO. Booths 344-5

Display of refractory brick, including Biasbrix, Grefco high temperature cement, Arcofrax high alumina brick and hand made brick.

Representatives: M. E. Pumphrey, K. M. Karcher, L. Tschirky, M. C. Sargent, J. T. King, G. F. Cooper.

GILLIS & GEOGHEGAN Booths 86-8

Ash removal and equipment and safety devices for protection of operator and pedestrian, during ash removal or ventilation of boiler room.

Representatives: C. E. Prout, advertising manager; J. H. Donat, W. H. Staples, F. W. Gillette, J. F. Shiel.

GIRTANNER ENGINEERING CORP. Booth 206

Working model of ash removal and conveying equipment including steam jet, hydraulic, steam and sand vacuum and water sluicing systems.

Representative: J. J. McNulta.

GOETZE GASKET & PACKING CO. Booth 252

Metal corrugated gaskets with long fibre asbestos filling for flanges, cylinders, hand holes, tube caps, and valves.

HENRY A. GOLWYNNE, INC. Booths 429-30

Shamva Mullite super refractory brick in standard and special shapes; electric furnace roofs in single pieces and segments; crucibles and porcelain insulators and needles.

Representative: Meyer L. Freed, research engineer.

JAMES T. GORDON CO. Booth 92

Water and oil strainers, worm gear and reduction gear unit, Nicholson steam specialties.

Representative: James T. Gordon.

A. P. GREEN FIREBRICK CO. Booth 202

Refractory products and plastic material for high temperature work; air setting cement; special shapes of fire brick.

Representatives: George E. Ford, vice-president; J. Harrison Brown, secretary; H. B. Plunkett, sales manager.

GREEN FUEL ECONOMIZER CO. Booths 648-9; 58-9

Portions of tubular and plate type air preheaters, forced draft fan, working model of cindertrap to remove solids from flue gases.

Representatives: Wm. A. Frame, secretary; J. M. Birkenstock, F. K. Howell, C. S. Messler, H. R. West, Beacon, N. Y.; F. R. Brinckerhoff, W. F. Wurster, New York; R. T. Forbes, O. S. True, Boston; R. N. Turner, Chicago; Jas. L. Henderson, Pittsburgh.

GRINNELL CO. Booths 530-1, 548-9

Full line of Triple XXX equipment for super power piping, including various types of flange joints, lap joint pipe, brackets and pipe stands, protection saddles, adjustable hangers and supports.

Representatives: Howard E. Branch, sales promotion department; A. W. Moulder, manager; J. C. Hartwell, eastern district manager; Edward J. Morris, engineer, New York City; H. P. Conway, southern district manager, Charlotte, N. C.; Fred M. Daugherty, central district manager, Warren, Ohio.

GRISCOM-RUSSELL CO. Booth 49

Evaporators and heat exchanging apparatus, including Reilly and G-R Bentube evaporators, Reilly, G-R and Russell water heater, multiwhirl oil coolers, Stratton separators and U-Fin generator air coolers.

HAGAN CORP. Booth 21

Hagan products for combustion control, steam purification, boiler water conditioning, desuperheating and pressure control. Electrically operated control apparatus, working exhibit of centralized boiler control system, steam purifiers and Hall system of boiler water conditioning.

Representatives: D. J. Erikson, J. M. Hopwood, R. R. Donaldson, T. A. Peebles, G. W. Smith, Dr. R. E. Hall, Pittsburgh; L. Wharton-Bickley, Philadelphia; C. R. Matheny, P. S. Miller, New York; James Mess, Canadian representative; R. L. Sheraton, Boston; Joseph H. Spurgeon, Detroit; H. W. Jarrett, Cleveland.

HARDINGE CO. Booth M, 26

Ruggles-Coles dryer, Hardinge clarifier and filter, action picture of Hardinge conical mill and air clarifier, working model of unit coal pulverizer to demonstrate quick control of fuel and constant fineness of pulverization at all capacities.

Representatives: G. F. Metz, W. H. Withington, J. K. Towers, A. H. Bamman, D. R. Judd, M. C. Fleming, L. H. Biggar.

HAYS CORP. Booth 81

Flue gas analyzer, portable combustion test sets, draft gages and automatic CO_2 and draft recorders. Panel of pointer type gages showing combinations and styles of mounting.

Representatives: P. T. Sprague, president; W. C. Edge, general eastern sales manager; A. F. Bittner, New York manager.

A. J. HEMPHILL CO., INC. Booth 611

Swivel truck casters for light and heavy duty, with various designs of ball races and all types of wheels. Power transmitting machinery and roller bearings.

Representative: Elmer S. Cook.

HENDRICK MANUFACTURING CO. Booth 431

Details and method of use for construction of stairways and walkways of Mitco interlocked steel grating and Mitco Shur-Site stair treads. Perforated metal screens and elevator buckets.

Representatives: Mr. Dann, Mr. Tappen, Mr. Tull, Mr. Scott, Mr. Krulder.

PAUL F. HERMANN Booths 737-8

Stationary and operating industrial models for advertising purposes.

Representative: Paul F. Hermann.

E. VERNON HILL CO. Booth 212

Gages, air testing instruments and psychrometers.

Representatives: E. V. Hill, president; O. W. Armspach, vice-president; P. J. Marschall, sales manager.

HOFFMAN SPECIALTY CO. Booths 633-4

Working demonstration of traps, also heat control specialties and air valves.

Representatives: C. V. Haynes, R. R. Emerson, H. P. Kahn.

THE M. A. HOFFT CO. Booth 323
Stoker, arch, screw conveyor and paddle wheel feeder for refuse, in operation to show the method of feeding.
Representatives: M. A. Hofft, president; N. T. Puckett, Walter M. Squires, Indianapolis; William R. Van Nortwick, New York.

HOMESTEAD VALVE MFG. CO. Booths 443-4
Blow-off valves for pressures to 250 lb. and cast steel blow-off combination valves for higher pressures. Quarter-turn lubricated valves, the larger with gear mechanism and all of lubricated type. Remote control protected seat hydraulic operated valves for heavy hydraulic presses.
Representative: W. R. Schuchman, president.

HUBAR-JONES CORP. Booths 689A-706
Godfrey oxygen jet cutting machine for cutting metals to outside and inside shapes by the use of oxygen blow torch.
Representatives: H. Hulatt, president; A. C. Barfield, vice-president; W. R. Jones, secretary and treasurer; Emmons B. Stone, mechanical assistant; Miss C. H. Knutsen.

HUBER STOKER CO. Booth 46
Stokers in operation showing the method of precoking coal and supply of secondary air.
Representative: D. T. Dobyns.

HUHN MFG. CO. Booth 756
Steam specialties.
Representatives: A. V. Manni, A. C. Judd, M. Bee, E. S. Rockefeller.

THE PAUL B. HUYETTE CO. Booths 81-2
Hays CO_2 recorders, draft gages and gas analyzers. Cochrane flow meters; Ajacks damper regulators; Reliance safety water columns. PBH water gages, gage cocks, water gage adaptor, gage glass protector, gage glasses and boiler panel.
Representatives: Paul B. Huyette, president; Walter C. Edge, vice-president; S. L. Huyette, treasurer; H. R. Blessing, J. J. McCarthy, P. Wood, A. Bittner, Mr. Malokie.

HYATT ROLLER BEAR'G CO. Booths 497-8
Complete line of roller bearings for industrial use including roller bearing journal box for steam railway cars and split-box line shaft bearing.
Representatives: H. O. K. Meister, general sales manager; H. M. Carroll, advertising manager; D. H. McAvoy, manager eastern division; R. P. Sanborn, W. W. Young, F. U. Naughton, Jr., E. P. Stahl, F. H. Arlinghaus, J. M. Grady, T. A. Farrell, F. L. Dallery, V. N. DeLamater, J. W. Wiley, W. F. Mattison.

ILG. ELEC. VENTILATING CO. Booth 278
Multi-blade blower driven by variable speed motor; heating type electric unit; portable floor fan.
Representatives: J. M. Frank, P. B. Briggs, J. O. Lennon, W. L. Thomas, C. A. Suling, E. M. Simmons, G. L. Heays, W. Burbo, L. Grout.

ILLINOIS ENGINEERING CO. Booth 232
Glass working model of Eclipse steam trap showing action of valve, also complete line of steam and vapor specialties.
Representatives: A. L. Browne, Walter S. Dickson, New York; James C. Matchett, John L. Ehretsman, Chicago.

IMPERIAL COAL CORP. Booth 729
Classification of coals for power and domestic use, also results of evaporation and efficiency tests.
Representatives: Charles A. Owen, president; E. H. Zimmerman, sales manager; A. E. Nevins, P. F. Masse.

INGERSOLL-RAND CO. Booths 544-7
Cameron pumps and special features of Ingersoll-Rand condensers. Multi-stage boiler feed pumps for pressures up to 1500 lb. with Kingsbury thrust bearing.

INS'T W'T'R H'T'R SALES DIV. Booth 440
Demonstration of instantaneous method of heating water for power plant house service supply.
Representatives: Messrs. Prizer, Yoder, White, Olson, Sprenkel.

INSULATING PRODUCTS CORP. Booth 437
Insulating materials for steam systems and special methods of application.
Representatives: W. J. Greer, president; H. E. Rowaldt, Robert Graf.

INTERNATIONAL COMBUSTION ENGRG. CORP. Booths 23-25A
Pulverized fuel systems of central and unit type, Lopulco system for burning pulverized fuel, water cooled furnace walls, full size elements of C-E air heaters, combustion steam generator as model and in motion pictures.
Representatives: James Cleary, J. D. Harrison, Paul H. Smith, J. V. Baum, B. J. Schneider, T. J. Cleary, Frank Henderson, F. L. Farrell, Walter Springe, Arthur Ginn, C. Schillinger.

INTERNATIONAL NICKEL CO. Booth 9
Commercial forms of monel metal and nickel, also manufactured parts showing the use of monel metal in vital parts of power plant equipment.
Representatives: L. Muller-Thym, in charge; R. E. Mason, E. A. Turner, L. R. Larson.

IRON FIREMAN AUTOMATIC STOKER CORP. Booths 682-3
Automatic furnace especially designed for handling low pressure heating plants up to 200 hp.

IRVING IRON WORKS CO. Booths 438-9
Irving products including subway open steel ventilating flooring, streamline modification, Irving Vizabledg Safstep, and unified system of reinforcement and surface armor for concrete bridge floors.
Representatives: E. Brodhead, sales manager; Wm. Noblett, F. C. Yale, C. S. Line, J. H. Miller, sales engineers; J. A. Voskamp, research engineer.

D. O. JAMES MFG. CO. Booth 752
Speed reducers for direct and angle drive in herringbone gear type and in spur gear type also vertical drive spur gear reducers and heavy duty worm gear speed reducers. Cut gears, rawhide and bakelite pinions and Universal couplings.

JENKINS BROS. Booth 90
Valves for water, air, steam and gas. Mechanical rubber goods for power plant uses. Rapid action valves for control of water. Moncrieff gage glasses.
Representatives: F. G. Jolley, Charles Beckmann, Charles Wick, Charles Stallings, W. G. LeCompte, A. E. Engle.

JOHNS-MANVILLE, INC. Booths 314-5
Asbestos and products made by this company, such as packings, power specialties, insulation, roofings and electrical material. Processes for the manufacture of asbestos products and demonstration of saving in heat energy by use of insulation.
Representatives: B. C. McClure, A. T. Aieselbach, S. Wakem, M. K. Cummings, M. Craighead, E. Rock.

JOHNSON SERVICE CO. Booths 403-4
Temperature control systems for steam and hot water heating and details of apparatus.
Representatives: T. A. Riccis, Frank P. Brophy, Victor M. Lathers.

W. A. JONES FOUNDRY & MACHINE CO. Booth 493
Spur and worm gear speed reducers in double type spur gear and heavy duty worm gear types.
Representatives: F. H. Hoge, James A. Porter, W. F. Brownell, Robert B. Moir.

JUSTUS STEAM TRAP CO. Booth 715
Operating demonstration of Justus traps and thermostats.
Representative: H. W. Justus.

E. F. KEATING PIPE BENDING & SUPPLY CO. Booths 229-30
Van Stone joints made from genuine wrought iron and from steel pipe for high pressures and temperatures; large pipe bends, welded flanged headers and coils of brass, copper, steel and wrought iron for power plant and industrial use.
Representatives: E. F. Keating, president; E. J. Coniff, vice-president; M. Readey, manager of sales; H. E. Neely, assistant manager of sales; George Kraus, Jr., Wm. G. Coffin, James J. Gaffney, J. A. Walsh, B. Kirchhoff, L. C. Brower, A. G. Ivers, F. C. Shannon.

E. KEELER CO. Booth 211
Glass boiler models in operation to show internal working of boilers, also section of water-tube boiler header and detailed parts.
Representatives: E. G. Wein, general sales manager; R. E. Foresman, advertising and sales; A. C. Lippincott, district manager; A. C. Lippincott, Jr., sales engineer, New York, N. Y.; H. L. Peel, Geo. W. Crawford, G. A. Barrows, sales engineers.

KEITH DUNHAM CO. Booths 643-5
Complete operating plant, extracting oxygen from the air. Pipe bends with walls of uniform thickness.
Representatives: M. Keith Dunham, president; C. J. Haines, vice-president; L. M. Zimmer, vice-president; D. A. Ahldin, James W. Dunham, Ludwig Zengeler, Don B. McCloud, engineers.

M. W. KELLOGG CO. Booth 16
High-pressure steam piping and fittings, including forge welded nozzles and flanges, also Dean Swingate and parallel slide gate valves.
Representatives: H. B. Kendall, sales manager; H. L. R. Whitney, William McCallister, Jr., George E. Kreidler, Frederick Cromwell, D. M. Wyman, Payne Dean.

KENNEDY-VAN SAUN MFG. & ENGRG. CORP. Booth 291
Animated picture showing company products in operation.
Representatives: H. W. Johnson, D. A. Cheyette, John V. Pyle, T. J. Shearer, A. J. Kutchera, Guy D. Leopold.

KEYSTONE LUBRICATING CO. Booth 3
Keystone safety lubricator for man-

ual, spring automatic and pneumatic operation, also various systems of pressure lubrication and regulating valves. Liquid greases for motor bearings and high temperature grease for abnormal temperature conditions.

Representatives: H. A. Buzby, president; A. T. Lowry, New York district manager; L. A. Webster, New England manager; H. M. Ludwick, lubricating engineer; C. O. Norstrum, F. D. Street, sales engineers; J. M. Potts, W. J. Robinson, New York; C. T. Moyer, J. R. Lawrence, Philadelphia.

KEYSTONE REFRACTORIES CO. Booth 11
Special high temperature fire brick cements and refractories and Keystone sprayer for application in liquid form.
Representatives: Frederick W. Reisman, president and general manager; R. L. Woodward, B. G. Pitcher, F. M. Leach.

KIELEY & MUELLER, INC. Booths 533-4
New designs and improved features developed during the past year, of pressure reducing valves, back pressure valves, steam traps and other steam specialties.
Representative: C. H. Dutcher.

KILSOOT CHEMICAL CO., INC. Booth 721
Kilsoot compound for removing soot from boilers and stacks.
Representative: E. L. Geldert, manager.

KING REFRACTORIES CO., INC. Booth 95
Boiler baffling and high temperature cement, Flame brand cement for high temperature requirements.
Representatives: S. C. Smith, president; John T. Bulkeley, vice president; E. J. Bulkeley, S. P. Lithgoe, T. Amory Coffin.

KISSICK-FENNO CO., INC. Booth 19
Vulcan soot cleaners and operating valves, Copes feed water regulators and pump governors exhibited in action.
Representatives: Joseph Kissick, Jr., W. J. McDonough, New York; George F. Fenno, Carl R. Fischer, Philadelphia.

WM. F. KLEMP CO. Booth 757
Diamond gratings for floors, stairways and runways.

KLINGERIT, INC. Booth 317
Klingerit products, including asbestos sheet packing and gaskets and discs for Jenkins valves. Klinger's two-color stuffing box packing and rings, piston valves and reflex water gages.
Representatives: Herman Strahman, C. H. Strahman, W. C. Jaegle.

KORFUND CO., INC. Booth 627
Troy engine in operation showing the use of vibro-dampers to prevent transmission of vibration and noise. Also blueprints, photographs and descriptive materials showing various uses of the device.
Representatives: H. F. Hoevel, president; S. Rosenzweig, vice president; C. H. Steffan, sales engineer.

LADD WATER TUBE BOILER CO. Booth 91
Details of construction, baffling and arrangement of the Ladd boiler.

LAMONT CORP. Booth 619
Waste heat steam generators, steam flow duplex valves and water film screen, the last named being a development perfected since the last show and specially featured.
Representatives: W. D. LaMont, J. B. Scheel, W. S. Anderson, Jr., A. F. Ernst.

LANDIS MACHINE CO. Booth 708
6-in. power-driven pipe threading and cutting machinery and nipple-making machines. Collapsible taps.
Representatives: F. C. Delcher, J. A. Cover, M. B. Henneberger, C. F. Meyer, C. N. Kirkpatrick, sales manager.

LEAD LINED IRON PIPE CO. Booth 86
Wakefield amalgamated lead-lined iron pipe, fittings and valves for hot and cold water service; also acid resisting pipe fittings and valves and tin-lined pipe fittings and valves.
Representatives: T. E. Dwyer, J. D. Dwyer, D. H. Regan.

LEAVITT MACHINE CO. Booth 432
Globe and gate valve reseating machine in use as in actual service in the plant. Dexter valve reseating machines in detail for globe and gate valves and for pump valve seats.
Representatives: Evans G. Valens, E. S. Hersey, sales engineers.

LEEDS & NORTHRUP CO. Booths 433-5
L. & N. systems of metered combustion control, CO_2 meters, temperature recorders for flue gas, steam and feed water, generators and transformers, recorder for condenser leakage and frequency meter.
Representatives: L. O. Heath, in charge; B. F. Keene, D. E. Moat, J. H. Hayner, R. Cleeland.

LESLIE CO. Booth 505
Automatic regulators for steam, air, gas, oil, water, pressure, excess-pressure and pumps; reducing and relief valves; self-cleaning strainers.
Representatives: S. I. Leslie, president; J. J. Cizek, vice president; J. M. Naad, secretary and treasurer; S. Soderberg, mechanical engineer; F. J. Thrush, J. A. DeLong; F. D. Riggio.

LINCOLN ELECTRIC CO. Booths 766-7
Linc-Weld motor running submerged in water and Stable-Arc welder in operation so that visitors can watch the process.
Representatives: G. N. Bull, S. G. Morris, Forest Kessler.

THE LINDE AIR PRODUCTS CO. Booths 265-6
Applications of oxy-acetylene welding for building up steel pipe structures and a demonstration of oxy-acetylene welding.
Representatives: R. W. Boggs, A. G. Wikoff, W. I. Gaston, D. E. Roberts, C. W. Greene, H. H. Moss, Herman Ullmer, H. E. Rockefeller, E. E. Radcliffe, E. S. Kelly, F. W. Mittenmeyer, C. V. Titus.

LINK-BELT CO. Booths 677-9
Herringbone speed reducer, vibrating screen, anti-friction belt conveyor idler, Caldwell speed reducer and car spotter, silent chain and other chain drives, coal handling equipment, including crushers, feeders, conveyors, skip hoists and other unloading and reclaiming devices.
Representatives: H. J. Kiely, Harry Strube, Frank Webster, C. A. Woerwag, Geo. L. Morehead, Frank B. Caldwell.

LIPTAK FIREBRICK ARCH CO. Booth 202
Self-supporting refractory side walls for furnaces; suspended arch and side wall construction.
Representatives: George E. Ford, vice president; J. Harrison Brown, sales manager; W. H. Boyd, H. E. Sharp.

LIQUIDOMETER CO. Booth 762
Distance reading liquid level gages working on balanced hydraulic principle, recording float position for tanks under air, hydraulic pressure or vacuum.
Representatives: C. A. deGiers, sales manager; A. J. White, R. H. Lockwood, sales department; H. Cullinan, J. E. Reis, engineering department.

LOCKE REGULATOR CO. Booths 444-5
New designs of pressure reducing, float control, safety shutoff, non-return, balanced and exhaust relief valves; damper and hydraulic regulators; automatic engine stops.
Representatives: L. J. Garrigan, manager; William A. Heaney, E. S. Kyle, A. P. Olches, D. J. Rowland, W. J. Kyle, William Burns.

E. G. LONG CO. Booth 752
Power transmission materials and appliances, including chain drives and belting, conveying and power transmitting machinery, made by D. O. James Mfg. Co.
Representatives: E. H. Mays, president; T. H. S. Andrews, W. E. Petty.

LUNKENHEIMER CO. Booth 63
Complete line of valves in steel and bronze bodies for all pressures and for all power plant uses.
Representatives: David C. Jones, Alfred J. Jupp, Charles A. Brown, Frank P. Rhame, Oliver F. Gang, Fred H. Hehemann, W. J. Angert, Walter A. Reynolds, H. S. Whitney, Philip Smith, William Carson.

MCCLAVE-BROOKS CO. Booths 561-3
Forced draft chain grate stokers, dumping and shaking grates, hand-fired stokers with operation demonstrated.
Representatives: R. B. McClave, general manager; C. A. Warg, mechanical engineer; S. A. Brooks, manager; Roy B. Emmert, J. C. Stewart, A. J. Baldwin, sales engineers, New York office; George Blair, Jr., Philadelphia manager; K. R. Hoffman, Buffalo manager; George H. Sanger, manager; H. P. Grohn, sales engineer, Chicago office.

MCLEOD & HENRY CO. Booth 13
Steel mixture for furnace linings, flat suspended arches and the use of Steel mixture for boiler settings.
Representatives: C. N. Morgan, president; A. L. Keeler, vice-president; G. A. Soper, secretary and assistant treasurer; F. V. Tuthill, N. S. Burnham, T. J. Fitzpatrick.

MANISTEE IRON WORKS Booths 219-20
Roturbo pump in eight stage horizontally split form; single stage volute pump and Roturbo impeller.
Representatives: D. J. Rowland, E. S. Quakenbush, A. P. Olches.

MANNING, MAXWELL & MOORE, INC. Booth 60
Hancock union bonnet forged steel valve for 450 lb. pressure; Ashcroft power control valve; Ashcroft gages; Consolidated safety valves; Hancock bronze and cast steel globe and gate valves.
Representatives: W. P. Bradbury, sales manager; Philip Ryan, Henry Jude, Walter Blackmore, Albert Phillips, W. J. H. Miller, H. D. Carlton, W. H. Williston, C. H. Graesser, P. G. Darling, E. B. Crocker, W. E. Jerauld.

MANZEL BROS. CO. Booth 705
Sight feed oil pumps in ratchet and rotary drive, single and multiple feeds for all types of machinery.

MARION MACHINE, FOUNDRY & SUPPLY CO. Booth 210
Marion type AB soot blower and detailed parts with demonstration of action of the blower. Marion Gulf Stream water heater for instant heating of water by steam.
Representatives: G. C. Kumming, sales manager; W. H. Caldwell, New York representative.

MARLIN-ROCKWELL CORP. Booth 337
Ball bearings in radial, thrust and duplex type, double and single row.

W. A. MARSHALL & CO. Booth 628
Trestle and coal pockets for handling bituminous coal; also Shallman and Havmar coals.
Representatives: Wilbur H. Marshall, president; John D. Kline, vice president; M. J. Breslin, C. W. Sandford, Frank R. Stuart.

MASON REGULATOR CO. Booths 223-4
Working model of combination fan engine regulator; reducing valves, balanced valves, hydraulic damper regulators, feed pump regulators, pump pressure regulators, liquid level float controllers.
Representatives: F. A. Morrison, secretary; F. K. Morrison, sales manager; H. L. Peiler, Canadian representative; W. P. Gearon, New England representative; H. L. Colby, mechanical engineer.

MAXIM SILENCER CO. Booth 654
Use of the Maxim silencer on Diesel engines, air compressors and similar equipment for eliminating discharge noise.
Representative: W. D. Stone, vice president; E. W. Higgins.

MERRICK SCALE MFG. CO. Booths 237-40
Automatic weighing devices including the Weightometer conveyor for weighing coal, Mechanical Weighman for tanks, Addoweight for totalizing weights passing over a track or platform, Weightoprint for weighing and recording individual packages passing over a conveyor system.
Representative: F. P. Hambright, sales manager.

MIDWEST PIPING AND SUPPLY CO. Booth 268
Globack joints with spherical backing for lap and spherical flange contact. Microphotographs of hot-worked metal structure.
Representatives: A. G. Stoughton, president; J. McC. Moffett, secretary; Paul F. Witte, advertising manager.

MIXING EQUIPMENT CO., INC. Booth 3-E
Electric portable mixers for industrial products.
Representatives: F. L. Craddock, sales manager; C. H. King, J. J. O'Shea.

MODINE MFG. CO. Booth 635
Thermodine unit heaters with fan and motor assembly; cabinet heaters and humidifiers.

MOORE STEAM TURBINE CORP. Booths 598-9
Small steam turbines including a single-stage unit with integral reduction gear for driving auxiliary equipment, pinion of a 1500-hp. reduction gear, turbine wheel for a 1000-kw. turbine, and boiler feed turbine and pump unit with pump governor.
Representatives: M. D. Church, president; G. R. Probst, sales manager; K. MacDonald, chief engineer; Joseph Lappin, Eugene Toussaint, New York representatives.

MORSE CHAIN CO. Booths 263-4
Model of Morse chain to demonstrate rocking action of rocker joint. Chain drive model with drip oiler to show constant lubrication. Spring sprocket to illustrate action under overload, full line of rocker joint chains and clock movement to show rocker joint action.
Representatives: V. D. Morse, W. W. Bertram, J. M. White, J. A. Meany, A. B. Wray, C. L. Saunders.

THE MOTO METER CO., INC. Booths 256-7
Motoco industrial thermometers and small pressure gages demonstrated as in actual use.
Representatives: H. G. Boynton, industrial division; Mr. Elverson, Mr. Bruckner.

MOTOR TOOL SPECIALTY CO. Booth 449
Snap-On interchangeable socket wrenches from ¼ to 2¼-in. Blue Point open end wrenches, Simplex open end ratchet wrenches, hand tools and special wrenches for cramped quarters.
Representatives: Stanton Palmer, president; N. E. Tarble, general sales manager; C. H. Tennyson, P. C. Huntley, industrial department; R. D. Holmes, F. A. Hoster, E. A. Glenn.

MULLITE REFRACTORIES CO. Booths 429-30
Shamva Mullite brick in standard and special shapes and use for furnaces, crucibles and insulators.
Representatives: Harry H. Davidson, chief engineer.

MURRAY CONDUIT SYSTEMS Booth 300
Construction of Murray monolithic conduit with motion pictures illustrating the operation of equipment under field conditions, samples of conduit and photographs of representative installations.
Representatives: William J. Lally, E. C. Tilley, E. L. Rich, Edward Hedther.

THOS. E. MURRAY, INC. Booth 301
Photographs and illustrations of plants designed and installed by this company.
Representative: Joseph C. Jones.

NASH ENGINEERING CO. Booth 66
Vacuum and condensation pumps; Jennings-Hytor heating systems, circulating pumps for hot water condensing systems and sewage ejection.

NATIONAL CO., INC. Booth 76
Water column illuminators for distant reading of water level.
Representatives: Mr. Ready, president; Mr. Wilson, engineer; W. K. Sowdon, Mr. Green.

NATIONAL REGULATOR CO. Booth 671
Temperature control and boiler regulators for high and low pressure and for vapor systems.
Representatives: J. H. King, president; D. F. Parker, eastern manager; John Morton, construction superintendent.

NATIONAL TUBE CO. Booths 8A, 8B
Shelby seamless tubing, National boiler tubes and pipe, welding scale free pipe and Van Stone flanges.
Representative: W. L. Shaffer.

NAUGATUCK MFG. CO. Booth 481
Seamless copper floats for power plant use; copper open tank floats from 1 to 20 in. diameter; seamless nickel floats for very high pressures.
Representative: C. P. Rodenbach, secretary.

NEEMES FOUNDRY, INC. Booth 93
Full size sections of dumping grates, shaking and dumping grates, hand-operated stoker, supported so that mechanism will be accessible for examination to demonstrate simplicity, compactness, ease of operation and of replacement.
Representatives: R. R. Rees, E. C. Welsh, A. B. Taylor, O. J. Vashrow.

HERMAN NELSON CORP. Booths 608-9
Uni-vent equipment for ventilation.

W. H. NICHOLSON & CO. Booth 92
Operating trap with glass windows and sides and welded nickel steel float for high pressures.
Representatives: H. S. Nicholson, manager; J. B. Armstrong, R. A. Comstock.

NILES GEAR CO. Booths 547-8
Modern gearing, especially of the Maag type. Hardened and ground gears for high speed drives, ground by a generating process to adapt them especially for high speed turbine work.
Representatives: A. C. Wais, general manager; W. A. V. Thomsen, eastern manager.

NORMA-HOFFMAN BEARINGS CORP. Booths 279-80
Ball, roller and thrust bearings, application to power plant machinery and demonstration of anti-friction qualities.
Representatives: D. E. Batesole, assistant engineering manager; O. P. Wilson, G. R. Bott, Norman Bell, H. J. Ritter, E. W. Lawrence, F. W. Mesinger.

NORTHERN EQUIPMENT CO. Booth 19
Copes boiler feed water regulator in operation, condensate drainage control system with tank and piping, pump governor, valve movement indicator and control valve.
Representatives: E. W. Nick, president; V. V. Veenschoten, vice president; C. E. Wolff, Jr., sales manager; E. L. Bowers, advertising manager; Neil H. Brown, H. H. Weining, engineers, J. J. Kissick, W. J. McDonough, New York representatives.

R. D. NUTTALL CO. Booth 684
Speed reducers, flexible couplings and heat-treated gearing with special-feature speed reducers in operation.
Representatives: J. E. Mullen, assistant sales manager; Roy S. Kratz, sales engineer; A. H. Cass, advertising department.

OAKITE PRODUCTS, INC. Booths 734-5
Demonstration of the application of Oakite cleaning materials and methods in power plants, especially for oil coolers, surface condensers, and like equipment.
Representatives: H. L. Gray, assistant manager; C. F. Radley, director of publicity; D. X. Clarin, district manager; W. H. Cook, J. A. Carter, J. W. Haines, New York.

S. OBERMAYER CO. Booth 260
Plastic refractories for monolithic furnace linings, refractory cement for boiler settings and furnace work; for power plants and metallurgical use.
Representatives: J. L. Cummings, manager refractory division; Geo. Doyle, sales engineer; H. E. Beckman, manager eastern division; F. P. Bullion, Newark.

OHIO VALLEY CLAY CO. Booths 429-30
Shamva Mullite super refractory brick in standard and special shapes and furnace roofs.
Representatives: James H. Gill, president; C. M. Hollingsworth, vice president; Fred T. Sandblade, chief engineer.

TINIUS OLSEN TESTING MACHINE CO. Booth 318

Dynamic balancing machines for indicating angle and amount of unbalance in rotors; static-dynamic type for balancing wheels, tires and other parts; Universal testing machine with automatic recorder for magnifying stress-strain diagram; hardness and ductility testing machines.

Representative: T. Y. Olsen, vice president and treasurer.

OTIS ELEVATOR CO. Booth 57

Commercial steel castings in various types made by electric process.

Representative: F. O. Drew.

HENRY PELS & CO. Booths 499-500

Triple combined punch, splitting shears, bar angle and tee cutter; shear for cutting angles, tees, rounds, squares and flats without changing knives; bar shear for round reinforcing bars on portable truck; hand-operated punching and shearing machine.

Representatives: I. Maddaus, president; T. C. Sternblad, secretary; E. E. Tailfer, Jos. Weigand, Thomas F. Kane.

PENNSYLVANIA CRUSHER CO. Booths 286-7

Working model of Bradford coal breaker and cleaner, also of Armorframe single roll crusher.

PHILADELPHIA GEAR WORKS Booth 10

Speed reducers and a display of cut gears.

Representative: J. K. Rewalt, New York.

PITTS & KITTS MFG. & SUPPLY CO. Booth 451

Steam accessories, including traps, valves, regulators, alarms, gages, gage cocks, high temperature cement and boiler wall covering.

Representatives: J. R. Hughes, president; S. Weinik, vice-president and treasurer; J. V. Garneau, sales manager; J. Huss, J. Hayes, sales representatives.

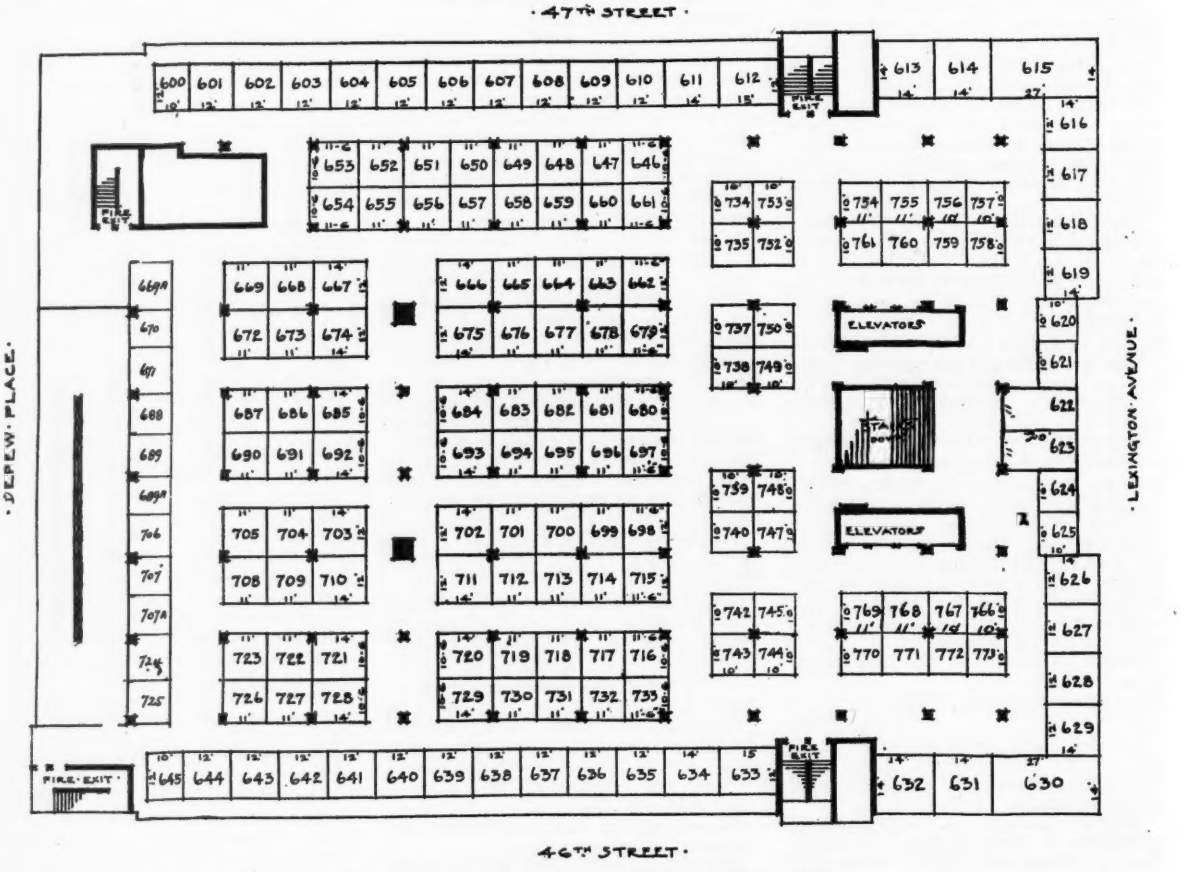


FIG. 4. FOURTH FLOOR PLAN. BOOTHS 600 TO 773

OXWELD ACETYLENE CO. Booth 530

Welding and cutting equipment as used by the acetylene process, also acetylene generators and demonstration of operation.

PAYNE-DEAN CO. Booth 16

Dean system of interlocking, distantly operating valve control.

PEABODY ENGINEERING CORP. Booth 47

Burners for powdered coal, fuel oil and gas firing, large capacity Toronto burner; novel insulated-front burner and automatic viscosity regulator for maintaining burner efficiency regardless of characteristics of oil.

Representatives: E. H. Peabody, president; H. T. Dyer, S. T. Warner, E. B. Sadtler.

PEERLESS UNIT VENTILATION CO. Booth 747-8

Suspended and floor type unit heaters.

Representative: Stanley B. Hawthorne.

PENNSYLVANIA PUMP & COMPRESSOR CO. Booths 522-3

Single-stage, belt-driven air compressor; single and multi-stage centrifugal pumps for low and high pressures; working model of air lift pump; models of air compressor valves and accessories.

Representatives: W. C. Peck, advertising manager; E. P. Meixsell, New York manager.

PERMUTIT CO. Booths 3, 28

In Booth 3 model of water softening and filtering equipment for industrial and power plant use. In Booth 28 Ranerex instruments for recording the composition and properties of gases.

Representatives: A. T. Smith, R. W. Epple, F. D. West, J. S. Shedden, D. J. Saunders, F. D. Harger.

PITTSBURGH PIPING & EQUIPMENT CO. Booths 420-1

Welded headers and nozzles, welded flanged joints, pipe bends and construction for pressures up to 900 lb. and temperatures to 750 deg.

Representatives: Geo. H. Danner, L. K. Hamilton, D. G. Sinclair, A. T. Brodie.

PITTSBURGH VALVE, FOUNDRY & CONSTRUCTION CO. Booth 4

Cast steel non-return valve with screw down device to allow minimum drop in pressure through the valve. Miscellaneous equipment and photographs of installations in large power stations.

Representatives: J. Roy Tanner, executive vice-president; C. A. Anderson, Jr., manager of sales; Geo. J. Stuart, manager of production; N. M. Templeton, chief engineer; Geo. B. Anderson, Jr., New York representative.

PLIBRICO JOINTLESS FIREBRICK CO. Booth 93
Moving picture entitled Fighting Furnace Failures and demonstration of use of Plibrico for furnace wall construction.
Representatives: I. S. Pieters, vice-president; C. A. Werner, New York manager.

POOLE ENGINEERING & MACHINE CO. Booth 467
Metal flexible couplings with internal and external gears, herringbone speed transformer with double gears running in oil or by splash system.
Representatives: E. W. Hardesty, general sales manager; C. M. Davison, chief engineer.

PORTER-CABLE MACHINE CO. Booth 667
Sanding and grinding machinery, also a portable motor-driven hand saw.
Representatives: Ward N. Gere, sales engineer; A. N. Frecker, New York.

WM. POWELL CO. Booths 494-5
Construction of valves from foundry to finished product and complete line of bronze, iron and steel valves in globe, angle, gate, check and safety form for pressures from 150 to 900 lb.
Representatives: William Heilig, William Hust, George T. Bloom.

POWERS REGULATOR CO. Booth 640
Temperature and humidity control systems, thermostatic regulators, shower mixers, steam traps, reducing valves and dial indicating thermometers.

PRAT-DANIEL CORP. Booth 656
Thermix assembled air heater and adjustable soot blower; streamline stacks, Type I for high drafts with induced draft fan, Type III for low drafts.
Representative: Louis C. Whiton, Jr.

PREFERRED UTILITIES CO. Booths 304-5
Oil burning systems for power and heating boilers; oil, gasoline storage systems.
Representatives: R. S. Bohn, president; G. W. Bohn, J. S. Kaplan, Arthur Roberts, Jack Spalding, Jr., J. A. Dixon.

PYRAMID IRON PRODUCTS CORP. Booths 306-7
Grates and details of grate settings.
Representatives: J. M. Dumphy, W. H. Cline, A. W. Foster.

PYROMETER INSTRUMENT CO. Booth 501
Pyro simplified industrial instruments, including optical and radiation pyrometers and tachometer.
Representatives: E. R. Wilner, F. Heidorn.

Q AND C CO. Booth 3-M
Sample bars of Nogroth metal and articles made from this material.
Representatives: E. R. Packer, vice-president and mechanical engineer; L. T. Burwell, vice-president; H. T. Henry, advertising manager; Godwin Shenton.

QUASI-ARC, INC. Booth 606
Electrodes and welding equipment.
Representatives: K. P. Strohmenger, treasurer; H. L. Ammann, technical director; G. J. Foster, A. J. Daivies, welding engineers; H. S. Ayers.

QUEEN'S RUN REFRACTORIES CO., INC. Booth 569
Fire brick for power plant furnaces and special shapes of intricate design.
Representative: J. S. Marshall, general sales manager.

QUIGLEY FURNACE SPECIALTIES CO. Booth 89
Three-reel motion picture of proper mixtures and uses of Hytempite cement for boiler setting, furnace construction and maintenance work. Refractory gun for placing pre-mixed plastic material on walls or arches, also applying Portland cement or whitewash. Special type of gun for applying hot tar, asphalt or pitch. Acid resisting cement for stills and chimneys. Triple A coatings for preventing erosion and corrosion on metal or masonry surfaces.
Representatives: W. S. Quigley, president; W. H. Gaylord, vice-president; J. H. McPadden, secretary; R. W. Walker, Quigley Co. of Canada, Ltd.; W. E. Braun, C. C. Gantzman, W. H. Kay, M. F. King, D. H. McMahon, J. R. Mack, H. M. Miller, S. F. Murphy, F. J. Spillane, H. W. Wood.

RAMSEY CHAIN CO., INC. Booths 292-3
Operating exhibits of silent chain, motor-driven and running free, to show reduction of friction and smooth operation.
Representatives: H. N. Davis, Frank G. Anderson, G. H. Johnson, R. MacArthur, E. Ferris.

RAWLPLUG CO. Booth 668
Fibre screw-anchors for holding screws into masonry and fast cutting masonry drills.
Representatives: M. L. Schulte, general sales manager; H. G. Janton.

READING IRON CO. Booth 229
Genuine wrought iron pipe and other wrought iron tubular material.
Representatives: John P. Feagley, Harold S. Bard, S. H. Blackwood, Jack L. Jacobson, Alexander Voripaeiff.

READING STEEL CASTING CO. Booth 48
18-in. iron body bronze mounted gate valve with motor control; 12-in. cast steel gate valve monel trim with motor control; 4-in. rustless steel trim gate valve; 12-in. cast steel flanged tee. Lantern slides showing advances in foundry and machine shop practice in the manufacture of valves and fittings.
Representatives: R. T. Hatch, general manager of sales; J. P. Ferguson, W. E. Foster, sales representatives, Bridgeport, Conn.; W. D. Cashin, Boston; E. C. Magens, New York; H. H. Freund, Jr., Philadelphia; W. McCausland, Pittsburgh; H. L. Leon, Charlotte, N. C.

REED AIR FILTER CO. Booth 209-A
Self-cleaning air filter, distributor and oil cleaners with complete unit in operation.
Representative: J. R. McConnell, sales manager.

REEVES PULLEY CO. Booth 26
Vertical and horizontal variable speed transmissions, also electric remote control type and automatic method of electric control.
Representatives: D. W. Clem, New York manager in charge; Carl M. Reeves, vice-president; E. Roy Baum, Boston manager; H. B. Diehl, H. W. Randolph, New York.

RELIANCE ELECTRIC & ENGRG. CO. Booths 620-1
Alternating and direct current motors for constant and adjustable speed with motor protective devices for severe conditions.
Representatives: J. W. Corey, assistant sales manager; R. H. Smith, Boston manager; C. D. Herbert, New York manager; A. B. Coffman, Philadelphia manager.

RELIANCE GAUGE COLUMN CO. Booth 81
Forged steel water columns for 750 lb. working pressure, with nickel floats, forged steel valves and gage cocks, with all seats and discs of chrome-silicon alloy, lapped and ground. Columns for 450 lb. and 250 lb. pressure shown in section. Manufacture of solid shell floats and models for low pressure alarms and gage cocks.
Representative: J. R. Brown.

REPUBLIC FLOW METERS CO. Booth 6
Republic boiler meter panel showing the method of making six individual records on one strip chart and animated sectional view of modern boiler showing points where readings are taken and the relationship between the records. Full line of Republic instruments, including meters for steam flow, water, CO_2, draft, liquid level, also pyrometers for indication and for record.
Representatives: J. D. Cunningham, president; G. D. Conlee, chief engineer; A. F. Spitzglass, research engineer; G. S. Hendrickson, New York manager; R. L. Morse, E. C. Horton, New York; J. W. Hogg, Philadelphia manager; C. E. Pritchett, Pittsburgh manager; Bryan Pritchett, Buffalo manager; J. A. Morehouse, Boston manager.

RICHARDSON SCALE CO. Booths 283-4
Working full size model of Richardson automatic scale for weighing coal from overhead bunker to hopper of stoker or pulverizer equipment.
Representatives: H. E. Godfrey, secretary and treasurer; C. R. Clark, New York manager; William F. Cohn.

RILEY STOKER CORP. Booth 79
Riley air-zoned super-stoker with five separate air zones independently controlled. Atrita unit pulverizer with flare type pulverized coal burner. Jones stoker unit with forced draft fan and gear box.
Representatives: William Pestell, Ollison Craig, L. V. Andrews, I. A. Taylor, R. J. Krieger, L. E. Griffith, W. T. Jordan, W. L. Schultz, Wilmer Mather, W. H. Whitty, E. C. Taylor, E. H. Schmitz, R. M. Bassett, M. L. Cornelious.

ROBERTS STEAM SPECIALTY CO. Booth 711
Safety water columns in cast and forged steel and water column equipment including water gages, gage lights, weighted lever gage cocks and floats in seamless copper, laminated steel and single wall construction of all kinds of metals.
Representative: G. W. Osborn, treasurer.

JOHN R. ROBINSON Booth 652
Steelbestos gaskets for water tube boilers; triple-blade tube hole cleaners; surface condenser packing.
Representative: John R. Robinson.

ROCHESTER ELECTRIC PRODUCTS CORP. Booth 655
Diverter pole motor generator set for floating on line to carry normal load and keep storage battery charged.
Representative: Edward F. Davison.

F. L. ROGERS & CO. Booth 694
Wodack brand of saws, special drills and combination lock mortiser and routing machines.
Representatives: F. L. Rogers, L. H. Rogers, J. G. Saloy, Oscar P. Wodack.

ROLLWAY BEARING CO. Booth 514
Heavy duty industrial roller bearings of precision type and roller bearing pillow blocks for line shafting.
Representative: C. A. Call, sales manager.

ROSS HEATER & MFG. CO. Booth 91
Cross head guided expansion joints

and internally guided joints, heat exchangers, heaters, jet and barometric condensers.

ROTO CO. Booth 11
Tube cleaners for cleaning boilers, evaporators, condensers and waterbacks. Boiler hand hole seat scrapers and cap cleaning machines.
Representatives: Walter M. Kelley, J. V. Doherty, sales engineers.

RUGGLES-COLES ENGINEERING DIVISION, HARDINGE CO. Booth 337
Ruggles-Coles dryer for pulverized fuel.
Representatives: G. F. Metz, W. H. Withington, J. K. Towers, A. H. Bamman, D. R. Judd, M. C. Fleming, L. H. Bigger.

RUGGLES-KLINGEMANN MFG. CO. Booths 558-60
Servo motors of hydraulic and motor-operated type for push button and master control. Solenoid operated valves. Step action regulators for control of pressure and temperature. Chronometer valves.
Representatives: Charles B. Klingemann, treasurer; James L. Kimball, mechanical engineer; F. N. Currier, New York sales manager.

SARCO CO., INC. Booth 33
Standard and special steam traps and temperature regulators for industrial plants, heating systems, refrigeration plants and special test work.
Representatives: E. J. Ritchie, R. W. Cumming, R. C. Doerr, E. E. Wells, J. L. Bruns.

SAUERMAN BROS. Booths 520-1
Working model of Crescent power drag scraper storing and reclaiming coal and other bulk materials. Motion pictures of Sauerman installations for storing and reclaiming coal.
Representatives: D. D. Guilfoil, G. R. Moore, Chicago; H. M. Cooper, New York.

SCANDIA MFG. CO. Booth 427
Bronander variable speed transmission changing from constant speed supply to a delivered speed of zero to full speed.
Representative: W. B. Bronander, president.

SCHIRMER CO. Booth 714
Viking power pumps.
Representatives: W. P. Schirmer, president; H. Fuhrer, Mr. Lawrence.

SCHUTTE & KOERTING CO. Booths 334-5
Pumping apparatus, condensers, stop, check and piston valves, steam purifiers, apparatus for heating liquids, electric control for valves, thermo compressors, Radiafin tubes, injectors, fuel oil burning systems.
Representatives: R. E. Hellmer, G. Heinemann, S. E. Derby, H. C. Woodward, Philadelphia; H. W. Philbrook, C. T. Keet, New York.

SCOVILLE MANUFACTURING CO. Booth 69
Brass tubing for heaters and condensers, brass rods and special brass products.
Representatives: Philip Davidson, Charles A. Gleason, George B. Kerr, Jr., L. L. Williams.

SERVICE RECORDER CO. Booth 707-A
Servis recorder for use in industrial plants to measure reciprocating, rotary or eccentric motion as a check on motor truck or machine tool performance.
Representatives: E. L. Viets, sales manager; R. W. Slates, production manager; H. A. C. Fay, New York manager.

SHAFER BEARING CORP. Booth 703
Complete line of self-alining roller bearings for industrial and railway application; hanger boxes, pillow blocks and other special equipment.
Representatives: J. E. Shafer, president; T. E. Kane, C. W. Dietrich, sales engineers.

SHARPLES SPECIALTY CO. Booth 92
Portable model of transformer and lubricating oil purifier; Presurtite totally enclosed super centrifuge; cross section of super centrifuge and action picture showing the working of the centrifuge.
Representatives: H. H. LaMent, vice-president; W. L. Marston, assistant sales manager; B. B. Davidson, New York manager; E. M. Noble, Boston manager; H. T. Moore, manager marine department; J. E. Paul, Philadelphia manager; Lee H. Clark, chief chemist; Arthur Ayres, chief engineer; Leo Jones, research engineer.

SHEPARD ELECTRIC CRANE & HOIST CO. Booth 632
Photographs of Shepard hoisting equipment from ¼ to 30 t. and close clearance hoist in operation.
Representatives: R. T. Turner, secretary; A. J. Barnes, district sales manager; R. W. Hurst, R. C. Vaughn.

SILENT HOIST WINCH & CRANE CO., INC. Booth 687
Electric capstans, winches and hoists for car and barge moving, for truck, boat and dock equipment. Worm gear speed reducers.
Representatives: J. W. Wunsch, president; Samuel Wunsch, secretary; A. R. Kuzel, engineer.

JOHN SIMMONS CO. Booth 509
Piping and accessories, photographs and illustrations of piping installations.
Representative: R. E. Thomas.

SIMPLEX VALVE & METER CO. Booth 76
Sectioned Simplex meter register for use with a Venturi tube to illustrate the functioning of the parts, also metering equipment for measuring of boiler feed, condensate and other water supply.
Representatives: M. M. Borden, chief engineer; Miles Read, assistant engineer; Hubert B. Smith, advertising manager; W. K. Sowdon, F. W. Greene, New York.

SKF INDUSTRIES, INC. Booths 332-3
Ball bearing transmission equipment with novel demonstration of antifriction bearings. Illuminated flag background.
Representatives: H. H. DeMott, A. Vieth, G. W. McAllen, C. A. Becker.

D. H. SKEEN & CO. Booth 31
Henszey De-concentrator for continuous boiler blowdown; Mercon pressure regulators for control of feed water supply; Mercon reducing and relief valves.
Representatives: D. H. Skeen, D. S. Walker, E. U. Titus.

SKIDMORE CORP. Booth 456
Return line vacuum and boiler feed pump on interceptor base; also a cut section of the unit to show the assembly.
Representatives: B. Skidmore, Jr., president; F. H. Sprague, secretary; W. D. Cashin, W. P. Parsons, M. McI. Dukehart, E. S. Denise, W. H. Eagan, G. D. Crider, H. G. Liptrott, representatives.

SKILSAW, INC. Booth 688
Portable electric handsaws in various models.
Representatives: L. J. Taylor, field supervisor; H. G. Hanley, eastern representative; W. C. Farr.

M. B. SKINNER CO. Booth 258
Pipe joint clamps, service saddles, pipe saddles, flange clamps and reseating tools.
Representative: M. B. Skinner, president; K. G. Merrill, vice-president and manager; F. A. McMurray, sales manager.

F. L. SMIDTH, INC. Booths 281-2
Models of Lenix short center belt drive showing automatic action and loss of power from belt slip. Also Lenix drive equipment.
Representatives: A. B. Zahn, assistant treasurer; V. Sahmel, R. Salmonsen, O. K. Hoest, B. Oberg, T. Offrel, J. Grant, O. Andreasen, B. F. Clark.

SMITH & SERRELL Booth 85
Francke flexible couplings of bushed laminated-pin type, shown in operation and in detail. Models of high speed and double floating ring couplings for severe conditions.
Representatives: R. A. Smith, J. J. Serrell, E. B. Gray, H. F. Field, H. Case, G. A. Dalton.

SMOOT ENGINEERING CORP. Booths 417-9
Combustion control system for regulating input of fuel and air with frequent and wide load changes to maintain uniform steam pressure and CO_2. Gas density regulator for detecting changes in fuel character or other elements affecting combustion.
Representatives: C. H. Smoot, R. A. Wright, C. L. Joly, C. J. King, S. B. DeCamp, H. R. Kessler, J. F. Shadgen, J. K. Mawha, H. K. Blanning, F. H. Plum, R. J. Cragg.

SNAP-ON WRENCH CO. Booth 449
Demonstration of time and motion saving by the use of Snap-on wrenches. Outfit for working in cramped quarters. Pipe wrenches, chisels, punches, hand tools.
Representatives: Stanton Palmer, president; N. E. Tarble, general sales manager: R. D. Holmes, F. A. Hoster, E. A. Glenn, P. C. Huntley, C. H. Tennyson.

SOWDON & GREENE, INC. Booth 76
Spray ponds, steam specialties including water columns, gages and controls, water system controls and meters and valves of reducing, relief, pilot and control types.
Representatives: W. K. Sowdon, F. W. Greene, M. Winn, E. Putnam.

SPENCER TURBINE CO. Booths 452-3
Turbo compressor for air supply to oil and gas furnaces; stationary vacuum cleaning equipment.
Representatives: S. E. Phillips, secretary; F. A. Wright, manager; E. J. S. Killman, Frank Martin.

SPRINGFIELD BOILER CO. Booths 31-2
Illustrations and parts of Springfield boilers to show construction and details.
Representatives: Owsley Brown, president; J. S. Hammerslough, sales manager; H. J. E. Banck, chief engineer; L. R. Merritt, R. D. Kleinert, New York representatives.

C. E. SQUIRES CO. Booth 663
Steam, air and gasoline traps; reducing and regulating valves; pump governors and boiler feed water controllers.
Representatives: George T. Ogden, Cleveland, and Frank Boyle, New York.

STANDARD STEEL & BEARINGS, INC. Booth 336
Latest aircraft engines with annular ball bearings. Full line of sizes of ball bearings for industrial machinery.
Representatives: W. H. Hill, sales manager; B. J. Shallow, assistant sales manager; A. E. Fawley, chief engineer; W. A. Bradbury, eastern sales representative.

STERLING ENGINE CO. Booths 446-7
Gasoline engines for driving pumps, generators and other mechanical service.
Representatives: Maurice E. Mutthler, general sales manager; Charles A. Criqui, Jr., advertising manager.

N. A. STRAND & CO. Booth 700
Flexible shaft machines of various types in operation in capacities from 0.1 up to 2 hp.
Representative: W. B. DaSilva, New York manager.

B. F. STURTEVANT CO. Booths 410-414; 483-4
Draft and ventilating fans, plate and tubular air preheaters, automatic control of steam turbine for fan drive, household blower for coal burning, household and industrial plant vacuum cleaning equipment.
Representatives: E. B. Freeman, vice-president; R. E. Shaw, sales manager; G. C. Derry, manager fuel economizer and mechanical draft dept.; H. M. Morton, manager of turbines; W. R. Yundt, manager vacuum cleaner dept.; H. M. Guilbert, manager utility dept.; G. W. Allen, manager, gas equipment dept.; A. L. Buckman, Camden manager; L. O. R. Clark, Hartford manager; W. C. Elliott, Montreal manager; J. F. Daggett, manager, H. S. Colby, A. C. Townsend, E. H. Gaither, G. B. Page, sales engineers, New York office; A. C. Bartlett, manager, R. E. Holmes, sales engineer, Boston office; C. P. Bridges, heating and ventilating dept.; Henry Daley, sales engineer, Philadelphia office.

STURTEVANT MILL CO. Booth 604
Motor driven automatic coal crusher and sampler in operation; also Whirlwind centrifugal selector for sizing dry materials finer than 60 mesh. Samples of material handled by the Sturtevant crushing and separating machinery.
Representatives: W. T. Doyle, manager engineering department; E. M. Young, eastern sales manager.

SUNLIKE ILLUMINATING CO. Booth 460
Illuminating apparatus for giving effect of diffused daylight and eliminating excess of red and yellow rays, in sizes from 50 to 1000 watts, for overhead, indirect, desk and panel board types.
Representatives: B. Einstein, I. Richman.

SUPERHEATER CO. Booth 56
Enlarged detail layout of boilers with Elesco superheaters showing standard and unusual conditions. Section of eccentric header for 804 lb. pressure.
Representatives: W. H. Armacost, B. R. Bristol, D. S. Carter, A. H. Charles Dalley, R. L. Ehmann, R. M. Gates, C. W. Gordon, F. A. Schaff, V. W. Smith, L. H. A. Weaver.

SWARTWOUT CO. Booths 696-7
"S-C" products for feed water regulation, for boiler pump regulation, for drainage control, for pressure reduction and regulation, for heat control; also steam traps, separators, exhaust heads and feed water heaters. Operating and working exhibit of Swartwout ventilator.
Representatives: D. K. Swartwout, Sr., president; D. K. Swartwout, Jr., vice-president; J. M. Barrett, vice-president; L. P. Russon, assistant general sales manager; H. S. Fraser, J. W. Johnson, P. R. Jones.

SWEET & DOYLE Booth 477
Folding machines for collar and for garter manufacture.
Representatives: E. B. Roby, A. F. Zak.

C. J. TAGLIABUE MFG. CO. Booth 59
Steam-operated and air-operated controllers for pressure, temperature, humidity, condensation and other conditions. Recording thermometers, pressure and vacuum gages, distant reading mercury recording thermometer, flue gas analysis and recording apparatus, oil testing instruments.
Representatives: L. C. Irwin, vice-president and general manager; H. D. Cooke, general sales manager; C. Wichum, chief engineer; R. M. Wilhelm, technical advisor; W. C. Begeebing, division sales manager; L. M. Hackenberg, Mr. Homeyer, sales engineers.

W. O. & M. W. TALCOTT, INC. Booth 723
Belt hooks and belt fasteners with method of application, also plate and rivet fastener for inserting between the plies of the belt.
Representatives: W. O. Talcott, president and treasurer; M. W. Talcott, vice-president and secretary.

TAYLOR INSTRUMENT COMPANIES Booth 507
Tycos indicating and recording thermometers and pressure gages for industrial and power plant work, long distance transmitting recorders for pressure and temperature, test thermometers, temperature and pressure regulators and barometers.
Representatives: J. W. Schwarz, manager industrial thermometer sales; J. P. Gilmore, H. W. Kugler, F. E. Ely, W. N. Maurer, W. N. Marlborough, C. B. Carson.

TEMPLETON BROTHERS, INC. Booth 274
Boiler feed and pumping traps in operation under compressed air.
Representative: W. R. Templeton.

TERRY STEAM TURBINE CO. Booths 207-9
Steam turbines, including complete unit and rotor of 500-kw., multi-pressure unit. Herringbone gears for speed reduction, flexible shaft couplings for turbine speeds and direct-connected turbine stoker drive with variable speed governor.
Representative: B. H. Wood, publicity manager.

TEXAS CO. Booths 641-2
Samples of lubricating products in oils and greases, method of preparation and determination of proper lubricant for various conditions.
Representatives: H. W. Dodge, G. R. Rowland, G. W. Vos, C. R. McCarthy, W. L. Kallman, F. W. Smith, L. O'Malley, H. MacRobert, Jr.

TIDE WATER OIL CO. Booth 15-A
Lubricating oils and greases for industrial and power machinery.
Representatives: J. M. Holmes, sales development; A. R. Nelson, New York; G. W. Daken, Boston; W. B. Joachim, Newark, industrial sales managers.

TIMKEN ROLLER BEARING CO. Booth 2-N
Bearings of type used in railway journal boxes, in steel mill roll necks and general assortment suitable for use on machinery in general.
Representatives: L. M. Klinedinst, S. C. Merrill, A. G. Norris, W. P. White, R. P. Kelley.

TOLEDO PIPE THREADING MACHINE CO. Booth 720
Pipe cutters and threading tools in sizes from ⅛ to 12 in., and high speed production pipe machine for sizes from ½ in. to 2 in.
Representatives: Clarence A. Popp, eastern manager of sales; Waynard Vosper, L. E. Kirby, F. D. Stuart.

TOLEDO SCALE CO. Booths 724-5
All types of scales for continuous weighing and automatic recording.

TOPPING BROS. Booths 512-3; 524; 528
Torchweld equipment, Simplex jacks, Cored bar products, twist drills.

TORCHWELD EQUIPMENT CO. Booth 525
Apparatus for gas welding and cutting, lead welding, decarbonizing and accessories and supplies for welding operations.
Representatives: W. A. Slack, president; R. M. Smith, assistant sales manager; L. R. McKean, Philadelphia; Roy J. Petty, New York.

TRILL INDICATOR CO. Booth 745
Trill indicators of single card and continuous card type, direct reading planimeter, Corry noiseless rotating check valve.
Representative: W. L. Trill.

TRI-LOK CO. Booths 401-2
Use of Tri-Lok grating and treads for ventilating flooring and as reinforcement for concrete floors.
Representatives: H. Nagin, secretary and general manager; W. H. Van Orden, assistant general manager; W. McKee, sales manager; C. A. Roberts, assistant sales manager.

TRIPLEX MACHINE TOOL CO. Booths 646-7, 661
Boring and gear hobbing machine, pipe machine and drill presses.
Representatives: John Cetrule, N. Cetrule, P. E. Seibel, James A. Murphy, F. C. Lord.

UEHLING INSTRUMENT CO. Booth 45
Electrically operated Apex CO_2 recorder and indicator; Uehling combined barometer and vacuum recorder giving automatic log of steam turbine performance.
Representatives: C. C. Phelps, C. J. Schmid, F. D. Bogia, P. J. Riccobene.

UNISHEAR CO., INC. Booths 475-6
Demonstration of the Unishear for cutting curves and complicated designs in sheet metal and also the heavier model for cutting steel plate.
Representative: Ulrich Senidors, president.

UNITED STATES ELECTRICAL TOOL CO. Booth 700
Drills, grinders and polishers in electric-driven portable type. Also bench and pedestal grinders.
Representative: W. B. DaSilva.

UNITED STATES TESTING CO., INC. Booth 689
Testing of coal and oil fuel illustrated.
Representatives: H. E. Bishop, sales manager; Edwin Kennedy, A. A. Cook, J. A. Woodhead, M. K. Ryan, C. S. Heustis.

VIKING PUMP CO. Booth 714
Viking power pumps.
Representatives: H. H. Fuhrer, Mr. Lawrence.

VINCENT-GILSON ENGINEERING CO., INC. Booth 17

Diamond soot blowers, Tracyfiers, Smith gas producers, Warren steam pumps, Kieley turbine blowers, products of the Engineer Co.

Representatives: C. R. Vincent, H. W. Gilson, C. R. Vincent, Jr., W. T. Ray.

HENRY VOGT MACHINE CO. Booths 269-70

Drop forged steel valves and fittings for high steam pressures and for extra high hydraulic pressure. Details and method of installation of water tube boilers.

Representatives: Henry Vogt, president; Soren Thurstensen, chief engineer; W. S. Cannon, Jr., assistant manager; W. A. Jackman, drop forged steel valve and fitting department; V. T. Collins, assistant manager, boiler sales department.

VULCAN RADIATOR CO. Booth 407

Tubes with extended surface in various forms for radiator, hot blast heaters and heating cabinets.

Representative: Y. Bergstrom.

VULCAN SOOT CLEANER CO. Booth 19

Self contained monel trimmed Vulcan operating head, ratchet operating head, Crodon corrosion resisting blower elements, detail parts of blowers.

Representatives: F. W. Linaker, vice-president and general manager; William C. Ihde, sales manager; T. M. Bruback, chief engineer; J. Kissick, Jr., G. F. Fenno, W. G. McDonough, C. R. Fischer.

WAILES-DOVE-HERMISTON CORP. Booths 261-3

Special construction and methods of lining coal and ash bunkers; enamels for prevention of corrosion of metals.

Representatives: Hugh M. Cook, assistant general manager; Paul G. L. Hilken, W. S. Adams.

WAITE & DAVEY CORP. Booth 58

Air cooled side walls, also suspended and rear combustion arches for air preheating.

Representatives: Frank H. Waite, president; D. W. Davey, K. H. Woolson.

J. D. WALLACE & CO. Booth 692

Woodworking machinery, direct motor driven, including saws, jointers, lathes and mortiser. Automatic glue pot and cutting tools.

Representatives: J. B. Murphy, district sales manager; F. Fox, P. Hardman, E. Herrick.

WALSH & WEIDNER BOILER CO. Booth 72

Section of 54 in. steam drum for 450 lb. pressure with special construction features. Standard high-pressure sectioned header and section header for 1400 lb. pressure. Water covered water wall; high pressure water gage; cross sections of various parts of the equipment. Photographs and drawings of high-pressure installations.

Representatives: A. C. Weigel, eastern manager; C. F. Weigel, chief engineer; J. G. Coutant, furnace and water wall engineer; E. W. Tait, J. S. Webster, V. M. McClure, New York office.

WALWORTH CO. Booths 308-11, 44-A

High-pressure valves for 1350 lb. with Sigma steel bodies and Sigma alloy trim. Sectioned valves for standard pressures. Motor-operated valves. Air testing of Kewanee unions.

Representatives: W. C. Mattox, advertising manager; F. W. Duemler, E. B. Keane, W. E. Stevens, J. J. P. Mackenzie, New York office; T. Nickerson, W. S. Murphy, New York branch; W. P. Kerr, Philadelphia; E. M. Monteith, Boston; H. C. Nannen, central division.

WAPPAT GEAR WORKS Booth 772

Alta portable electric hand saws, lock mortisers and planes for building and maintenance operations.

WARREN STEAM PUMP CO., INC. Booth 231

Centrifugal and steam-driven reciprocating pumps and sections in detail.

Representatives: William W. Shuttleworth, general manager and treasurer; John G. Rearick, chief engineer; H. W. Hathaway, sales manager; John B. Nibling, Philadelphia district manager; H. T. Waldo, Warren, P. A. Collins, Boston, sales department.

WARREN WEBSTER & CO. Booths 225-6

Webster systems of steam heating, including the R systems, Series 78 traps, and No. 026 drip trap, with latest developments and applications.

WATTS REGULATOR CO. Booth 39

Pressure reducing and balanced float valves; engine, slasher and hydraulic damper regulators; pump governors; monel metal pilot valves operating auxiliary pressure regulator; oil, water and feed heaters and pressure control valves for water, air, gas and oil.

Representatives: B. E. Horne, proprietor; W. M. Dillon, Chetwood Smith.

WAVE CUT FILE & TOOL CORP. Booth 669

Wave-cut files, self cleaning for use on all materials except lead babbitt. Hand forged vises, hack saw machines.

Representatives: K. Hoffmann, president; F. E. Koebel, vice-president; C. Pasch, secretary; Richard Seitz, depot manager.

WESTINGHOUSE ELEC. & MFG. CO. Booth 564-6

Turbine generator units; details of turbine construction; Micarta gears in various sizes and types; illustrations and arrangement of large turbine plant.

Representatives: C. G. Ong, C. C. Wylam, D. H. Grunagle.

WESTON ELECTRICAL INSTRUMENT CORP. Booths 510-11

Electrical measuring instruments and accessories, also electrical speed indicator.

Representative: C. B. Denton.

C. H. WHEELER MFG. CO. Booth 77

Radojet air pumps in two-stage and three-stage types with inter and after condensers; cross sectioned model of Radojet air pump; sectional drawing of Leach Fracto control condenser, also drawings and photographs of condenser installations and auxiliaries.

Representatives: C. H. Wheeler, Jr., vice-president and general manager; G. L. Kothny, executive engineer; Robert Kerr, chief engineer; B. K. Mould, New York manager; W. W. Clinedinst, New York; John Dobson, Philadelphia.

WHITNEY MFG. CO. Booth 249

Transmission chain including double bearing pin and bushing type, rolling joint type and standard steel roller chain.

Representatives: C. E. Wertmen, sales manager; D. I. Wheeler, sales engineer; R. J. Howison, Philadelphia manager; R. A. Glass, Connecticut.

WICKES BOILER CO. Booth 285

Lantern slide illustrations of shop operations in the construction of Wickes boilers, section of patented single joint header for horizontal cross-drum boilers, model of three-drum curved tube boiler and photographs and slides of installations.

Representatives: E. B. Wickes, vice-president; H. E. Aldrich, general manager; J. R. Fortune, sales manager; J. W. Hulihan, district manager; R. J. Stormont, sales engineer; E. A. Dunton, service engineer.

L. J. WING MFG. CO. Booth 61

Turbine blowers for individual boiler forced draft; motor-driven blowers for heating boilers; unit type heaters; Scruplex exhausters and blowers.

Representatives: A. E. Seelig, president; H. S. Wheller, vice-president; V. H. Carples, secretary-treasurer; C. H. Smith, C. L. Meyer.

T. B. WOOD'S SONS CO. Booths 479-80

Power transmission machinery of U. G. type including belt contactor, couplings, clutches, hangers and pulleys.

Representatives: W. H. Fisher, Charles E. Bailey, Guy Washinger.

WORTHINGTON PUMP & MACHINERY CORP. Booths 487-9

High-pressure, multi-stage centrifugal pumps for boiler feed up to 1600 lb. pressure; upper case removed to show volute diffuser. Three-stage, two-in-series oil pumps with U pipe connection between stages. Motor-driven horizontal duplex and triplex enclosed crank case pumps.

Representatives: C. W. Rice, H. L. Conklin, E. W. Hammond, K. F. Bernard, J. H. Messerly, C. J. Hood, R. H. Lloyd, F. W. Hankins.

WRIGHT MFG. CO. Booth 698

Chain hoist, trolleys and hand cranes.

Representatives: Richard F. Straw, George N. Walton, George A. Nichols.

WRIGHT-AUSTIN CO. Booth 436

Separators, water columns, steam traps, exhaust heads and other specialties. Kleervu gage glass protector and Airxpel bucket trap.

Representatives: C. B. Walter, president; Henry Dusenbery, New York manager.

"X" LABORATORIES Booth 259

Demonstration of "X" liquid for repairing steam and hot water boilers of high and low pressure type.

Representatives: Edward R. Tolfree, president; Carlton B. Stenton, advertising manager; L. D. Patterson, office manager; John W. Gannon, eastern representative; John M. Harder.

YALE & TOWNE MFG. CO. Booths 622-3

High lift and low lift electric trucks in 2 to 5-t. capacities, tractors and trailers, crane hoists in hand operated and electric operated types, cranes and crane ends.

Representatives: From Stamford, Conn., Henry J. Fuller, manager material handling equipment sales; Milton G. Peck, John R. Ramsdell, R. P. Anderson, W. T. S. Quicke. From New York office, R. E. Wilson, industrial trucks; Charles B. Veit, electric and hand chain hoists.

YARNALL-WARING CO. Booths 7-A, 7-B

Blow-off valves for pressures up to 1350 lb., spray pond model at work, water columns, inclined water gages, V-notch meter, pipe and joint clamps, hydraulic valves.

Representatives: L. G. Chase, New York, manager; D. T. Newman, sales engineer; F. W. Miller, mechanical engineer.

YOUNG PUMP CO. Booths 701-2

Centrifugal pumps for vacuum, boiler feed, handling of condensation, draining of receivers and general service work.

Ohio Falls Development Nears Completion

THIS PROJECT, BEING COMPLETED APPROXIMATELY ONE YEAR AHEAD OF TIME, IS A FINE EXAMPLE OF COORDINATION OF REQUIREMENTS FOR BOTH NAVIGATION AND POWER

CONSTRUCTION WORK on the power development at the Falls of the Ohio River at Louisville, Ky., is nearing completion, and it is expected that the formal opening will take place sometime the early part of December. This plant, which will be operated by the Louisville Hydro Electric Co., is the result of a thorough study of both the power and navigation problems of the river by the U. S. Engineers and by the Byllesby Engineering & Management Corp. for the Louisville Hydroelectric Co. The Byllesby Engineering & Management Corp. realized the importance of controlling the stream while constructing the hydro plant, procuring a tight dam and completing the dam so that operation of the hydro plant would not be delayed, and mainly for these reasons entered the competition and made the low bid that secured the contract.

On the basis of the river flow records for 46 yr., it is expected that there will be an average of only 20 days a year when the plant can operate at approximately full capacity, as the possible power output will be reduced either by a reduction in available water below the plant capacity of 32,000 cu. ft. per sec., or by the decreasing head due to backwater experienced in periods of ample flow, due to the rapid and excessive rise of the tail water under flood conditions. It is estimated that the plant will be out of commission for an average of 45 days a year.

Estimated cost of the power plant, including all equipment, transmission line from Waterside Steam Station to the Louisville Gas & Electric Co., and the substation at that plant is $7,500,000; $69.50 per hp., or about $93.50 per kw. installed. It is because of this comparatively low cost per kilowatt of installed capacity that the building of the plant, the output of which is entirely secondary power, is financially practicable. The present capacity of the steam plant at Louisville is 115,000 kv.a. and when needed additional steam capacity will be installed in a plant to be erected immediately adjacent to the new hydro plant.

The dam itself is L shaped, made up of a combination of fixed Chanoine and Boule sections. With one exception, all the dams on the Ohio River are of the movable Chanoine type designed to be lowered so as to permit open river navigation when the river discharge is sufficient for that purpose.

Eight units, each having a capacity of 13,500 hp. at 37 ft. head will be installed, provision for two additional units being made at the northern end of the power house, which measures 134 ft. long and 74 ft. wide. The turbines are as large as practice in wheel design will permit, the runners being nearly 15 ft. in diameter, with an operating speed of 100 r.p.m. At 37 ft. head each unit will pass about 4000 c.f.s. at full gate, making a total flow to the river when fully loaded of 32,000 c.f.s. The guarantee of the power output for operation under reduced head of 32, 27, 22, 17 and 12 ft. is 11,250, 8900, 6600, 4500 and 2600 br.hp. respectively. At reduced head the river flow is greater than plant capacity so that efficiencies at part gate are not important. At low flow, it will be possible to operate part of the units at full load efficiency guaranteed to be 87 per cent.

Power generated at 14 kv. will be collected on a double bus system. The double bus permits easy and safe inspection, and at the same time facilitates the segregation of machines in accordance with the load and river conditions and the requirements of general system operation. Electric energy will be stepped up from a generated voltage of 14 kv. to 66 kv. for transmission to local distribution centers in Louisville.

Generators will be totally enclosed with a closed system of ventilation. Leads have been brought out from the stator winding so that the generator can be operated Y connected at full load, and delta connected at partial load. When at ¾ load and above the generator will be connected Y. When operating below ¾ load, the generator connection can be changed to delta by means of suitable double throw disconnecting switches located just below the main floor, thus diminishing excitation requirements, decreasing losses, and permitting, through this increase in generator capacity, additional output of about 1,000,000 kw-hr. per yr., which would be lost were the generator to operate at all times Y connected.

New Edition of Stodola's Book on Turbines

STEAM AND GAS TURBINES, by Dr. A. Stodola, Professor at the Polytechnikum in Zurich. Translated from the Sixth German Edition by Dr. Louis C. Lowenstein, Consulting Engineer. McGraw-Hill Book Co., Inc., New York; two volumes, 1356 pages with 7 folding charts, $15.

In the first volume the fundamental laws of thermodynamics and flow of elastic fluids are covered before the subject of steam turbines is considered. Under the heading "The Conversion of Energy in the Steam Turbine," general relations and principal turbine types are covered; while in the "construction of the most important parts," the various items entering into the turbine are covered in considerable detail. This is followed by short descriptions and illustrations of practically all American and European commercial turbine types now on the market.

The second volume deals with the various types of marine turbines and turbines for special purposes. There is a chapter on condensers and condensation followed by a chapter on operating experiences which deal with practical turbine and condenser operating problems with a discussion of difficulties, such as corrosion, wear and vibration.

Theory and practice of all types of gas turbines is considered in the chapter on Gas Turbines. The book ends with a supplement on the prospects of the thermal prime mover, discussing the limiting possibilities of the various types of prime movers and proceeding to a discussion of recent improvements for steam plants and different phases of thermodynamics.

POWER PLANT ENGINEERING DEVELOPMENTS AND NEWS

Fairbanks-Morse Motors Show Development

ELECTRIC MOTORS have reached such a high degree of refinement and their general dependability is so unquestioned that the average user of motors is often apt to overlook the constant development which is going on in this equipment.

Although the standard open frame squirrel cage motor meets most of the requirements for ordinary service,

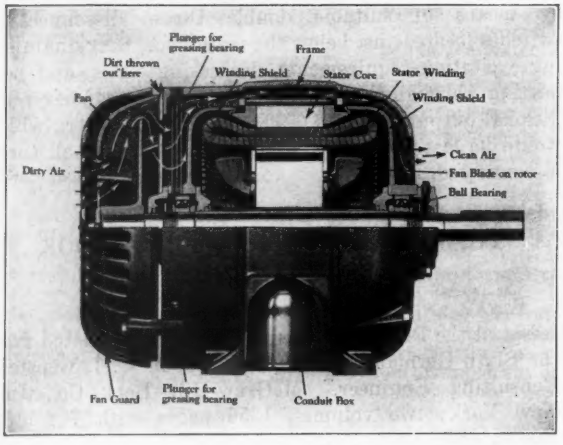


FIG. 1. WINDINGS OF THIS BALL BEARING MOTOR ARE TOTALLY ENCLOSED WITH WINDING SHIELDS; FAN IS DESIGNED TO THROW DUST AND DIRT OUT OF AIR BY CENTRIFUGAL ACTION

it has certain disadvantages which become rather serious in many applications, as where dust is present.

There has been a constant demand for an enclosed type of motor to meet these particular operating conditions and there have been a number of developments in enclosed motors in the attempt to solve this problem.

One answer to the problem appears to lie in the recent development of a line of enclosed self-ventilated types by Fairbanks, Morse & Co., Chicago, Ill., as shown herewith.

This motor, Fig. 1, has a standard stator core and windings and a standard rotor mounted in a supporting shell with an annular air passage between the outside surface of the stator core and the shell. Winding shields are provided so that the stator windings are totally enclosed, thereby preventing any dirt from gaining access to these windings. Cooling air is drawn through an inlet opening at the free end of the motor by means of a special type of fan which also functions as an air cleaner. The clean air is blown across the winding shield at the free end of the motor, through the annular air space, then across the outer end of the stator core laminations, thence across the winding shield at the pulley end and out through openings in the pulley end bearing arm.

The fan is of the closed impeller type and is so constructed that the foreign particles are thrown out by centrifugal force, between the edge of the outer shroud and the supporting frame. A perforated guard is placed around this fan-cleaner and is carried by the supporting frame.

Provision is made for lubricating the ball bearings of this motor, without removing the guard, fan or bearing arms, by the use of a plunger device located in a grease tube extending through an opening in the bearing arm into the bearing housing.

The simplicity of the squirrel cage motor has resulted in a widespread adoption of this type of motor in all applications where speed variation is not required and where alternating current is available. One main disadvantage of the squirrel cage motor, however, has been due to its high starting current.

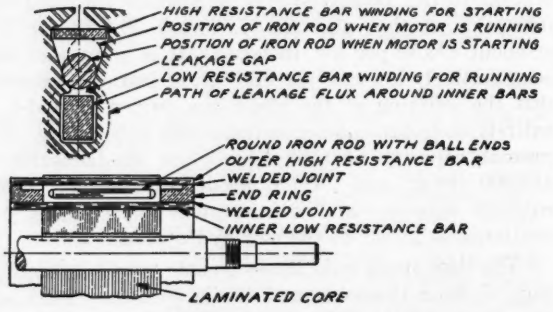

HIGH RESISTANCE BAR WINDING FOR STARTING
POSITION OF IRON ROD WHEN MOTOR IS RUNNING
POSITION OF IRON ROD WHEN MOTOR IS STARTING
LEAKAGE GAP
LOW RESISTANCE BAR WINDING FOR RUNNING
PATH OF LEAKAGE FLUX AROUND INNER BARS
ROUND IRON ROD WITH BALL ENDS
OUTER HIGH RESISTANCE BAR
WELDED JOINT
END RING
WELDED JOINT
INNER LOW RESISTANCE BAR
LAMINATED CORE

FIG. 2. AN IMPROVEMENT IN DOUBLE SQUIRREL CAGE MOTORS CONSISTS IN THE USE OF LOOSE IRON RODS IN EACH ROTOR SLOT BETWEEN THE INNER AND OUTER BARS

In the design of squirrel cage motors it is possible to use high resistance rotor bars in order to get a high starting torque with low starting current, but such a motor has comparatively low efficiency and poor power factor at full load and normal speed. If the motor is designed with low resistance bars in the rotor, then the starting torque is reduced and the starting current is increased although the motor has better operating characteristics at normal loads and speed.

During the past few years one of the motor developments has been what is known as the double squirrel cage type. The most recent development in a double squirrel cage motor is that of Fairbanks, Morse & Co. in a motor which is called a variable leakage double

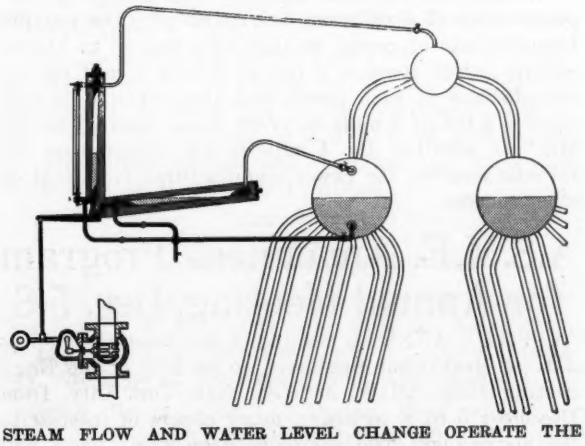
squirrel cage type. Figure 2 shows a section through the rotor slots which gives an idea of the construction of this motor. In this motor the current in the inner winding at starting is choked by means of movable iron rods. These rods are placed in each rotor slot between the inner and outer bars. The instant the motor is connected to the line the iron rods are pulled down towards the inner bars, closing the small leakage gap in the rotor iron which almost completely chokes the current in the inner low resistance winding by forming a complete iron circuit around each inner bar. This choking action on the inner winding forces practically all of the current to flow in the outer high resistance winding at starting, thus producing a high starting torque with a low starting current.

As the rotor accelerates, the iron rods are thrown out of the leakage gaps by centrifugal force which removes the choking effects from the inner winding when the motor is running. This is intended to give a better running performance than is possible with the older style of double squirrel cage motor. It is also possible to use much higher resistance in the outer winding where exceptionally low starting current is desired and where the starting torque requirements are moderate.

At starting there is a slight noise due to the rods changing position but since this change is practically instantaneous the noise is not objectionable.

New Copes Regulator for Large Boilers at High Ratings

THAT FEED WATER regulation may constantly keep abreast of the requirements of modern steam generation, a new type of Copes feed water regulator has recently been developed to meet the exacting de-



STEAM FLOW AND WATER LEVEL CHANGE OPERATE THE DOUBLE THERMOSTAT REGULATOR

mands of large boilers which are operated at very high ratings. The accompanying sketch shows the installation of this new type regulator on a Ladd boiler.

This new type regulator, made by Northern Equipment Co., Erie, Pa., is controlled by a combination of steam flow and water level movement. As illustrated, the regulator consists of a double thermostat, with two expansion tubes, each of which actuates the same control valve.

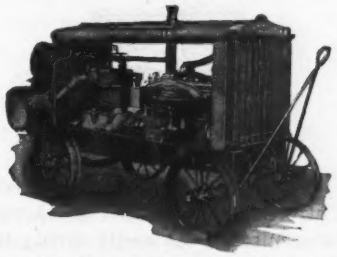
It will be noted that the water level in the expansion tube of the vertical thermostat is higher than the water level in the expansion tube of the diagonal thermostat for the reason that, on account of the friction loss through the connecting tubes, the steam pressure in the dry drum to which the steam connection of the vertical thermostat is made is less than the pressure in the main steam drum to which the steam connection of the diagonal thermostat is made.

The vertical thermostat is designed to operate normally the Copes control valve, increasing or decreasing the feed, dependent on the flow of steam from the boiler. As the flow of steam from the boiler increases, the drop in pressure between the main boiler drum and the dry steam drum increases. This causes the water in the vertical thermostat to rise. As the level in the vertical thermostat becomes higher, the thermostat contracts and opens the Copes control valve, supplying more water to the boiler. As the load decreases, the difference in pressure between the main boiler drum and the dry steam drum is lessened; consequently, the level in the vertical thermostat lowers and less water is supplied to the boiler.

If for any reason the vertical thermostat does not move the control valve a sufficient distance, there will, of course, be a change in water level in the main drum. This change in water level will affect the level in the diagonal thermostat. This thermostat will, in turn, readjust the valve and will compensate for the variation produced by the vertical thermostat. Any adjustment which may be necessary in the water level may be made by the nuts on the top of the vertical thermostat. Tightening the nuts will raise the water level shown in the boiler gage glass and loosening the nuts will lower the water level.

Gardner-Denver Offers New Portable Air Compressors

GARDNER-DENVER CO., formerly The Denver Rock Drill Manufacturing Co. and the Gardner Governor Co., has added a line of portable air compressors in five sizes to its list of products.



NEW PORTABLE AIR COMPRESSOR MADE IN FIVE SIZES

The five sizes adopted are intended to meet all requirements within the scope of a portable. From these a selection can be made to operate the required number of concrete breakers, clay diggers, rock drills, hoists, pumps or other equipment. The following table shows compressor bore and stroke in each model:

Class 110—2 cylinders....	6-in. bore by	4½-in. stroke
160—2 cylinders....	7-in. bore by	6-in. stroke
220—2 cylinders....	8-in. bore by	6-in. stroke

250—2 cylinders.... 9-in. bore by 6-in. stroke
310—2 cylinders....9½-in. bore by 6-in. stroke

The compressor speed has been kept within limits to insure dependable operation and long life.

These units are powered by heavy duty, four-cylinder Buda engines. Each size of engine is rated at a generous margin above the compressor requirements, an important factor in insuring dependable service. A high tension magneto with impulse starter insures quick starting in cold weather. A speed control governor holds the engine within the maximum r.p.m. limits.

Two-cylinder vertical, single acting Gardner compressors are used. These are light and compact and the water jacketing is large. Suction and discharge valves are of the duo-plate type, large in area. The engine drives the compressor through a flexible, quickly detachable coupling.

The frame is a single piece steel casting, with the air receiver and gasoline tank mounted on an extension. The air receiver is built to the A. S. M. E. standard, and is provided with safety valve, pressure gage and service outlets.

Ample cooling is effected by means of a large sectional type radiator, which is protected by heavy steel rods. This line of Gardner-Denver portable air compressors can be supplied on any standard mounting. They may be mounted either on skids, steel or rubber tired wheels, or on trailers. The small size is suitable for mounting on a Ford truck.

Danger Signs

HUMAN BEINGS, unfortunately, when they see danger signs are likely to give them no attention. Tuberculosis, called "the most terrible disease in the world," does not, as is often supposed, sneak up behind a person and clutch him in an unguarded moment. On the contrary, its symptoms are definite and easily recognizable, and it is timely to consider the ravages of tuberculosis now, for this is the month during which millions of the little Christmas seals are sold by the National Tuberculosis Association and its 1500 affiliated associations to aid them in wiping out tuberculosis and in educating the people in regard to its symptoms and treatment.

For the benefit of all, the associations announce that the following symptoms are the Danger Signs of beginning tuberculosis: too easily tired; lack of pep; loss of weight; indigestion; cough that hangs on; "all-in" feeling.

If you have any of these signs—especially a combination of any of them—don't take a chance. Let your doctor decide.

HUGH L. COOPER & Co., 101 Park Ave., New York, consulting engineers, are in charge of a hydroelectric power project on the Columbia River, Pend Oreille County, Washington, to have an ultimate capacity of more than 400,000 hp.

Alabama Power Co. to Build Warrior Steam Plant

THE ALABAMA POWER CO. has filed with the Alabama Public Service Commission an application for a certificate of convenience and necessity to build a new steam plant in the Warrior coal fields in Walker County, Alabama. If the certificate is granted, work on the plant will begin as soon as it is possible to secure the necessary labor and materials. The initial installation will consist of one unit of 50,000 kw. capacity with an ultimate capacity of 200,000 kw. The cost of the initial unit will be approximately $5,000,000.00 and the plant, when completed, will represent an investment of about $20,000,000.00. Completion of the initial unit is scheduled for October, 1928.

Increasing demands for power and the duty of a public utility to anticipate the actual needs of the State make it necessary, in the opinion of the officers of the company, to proceed with this additional plant. Aside from the public demand for more power, at the recent session of the Alabama Legislature there was created a privilege tax of 2/5 of a mill on each kilowatt-hour of hydro-electric power manufactured and sold. The Act also increases the coal tax so that it is now 2½c per ton. One ton of coal in the best modern steam plants will generate about one kilowatt-hour of power from each pound of coal, hence one ton of coal will generate about 2000 kw-hr. If this power is manufactured from coal it would, of course, pay the coal tax of 2½c. If, however, 2000 kw-hr. is manufactured at a hydro-electric plant, then the 2000 kw-hr. is subject to the tax of 2/5 of a mill per kw-hr. or a total tax of 80c. It will be seen that under the best steam plant conditions the relation between the two taxes may be as 2½c to 80c, or the hydro tax may be 32 times the tax imposed on power manufacture from coal.

In addition, the same legislature by Section 24 imposed a tax of 4 mills on each dollar of gross receipts from the sale of power, so that with respect to hydro-electric power there is a tax of 2/5 of a mill on the manufacture of such power and then when it is sold there is a tax of 4 mills on every dollar received for its sale. In addition, the 4 mills is also collected on the revenue received for power manufactured from coal or other sources.

A.S.M.E. Announces Program for Annual Meeting, Dec. 5-8

AT THE ANNUAL meeting of the American Society of Mechanical Engineers, to be held at the Engineering Bldg., 29 W. 39th St., New York City, from December 5 to 8, inclusive, many papers of interest to the power plant field are to be presented. These will deal with industrial power, use of fuels, feed water treatment, and there will be a joint session with the American Society of Refrigerating Engineers, which holds a meeting during the same period.

Following are some of the papers of interest:

TUESDAY MORNING, DECEMBER 6, 9:30 A. M.

The Ruths Steam Accumulator—R. A. Langworthy.
Stresses and Reactions in Expansion Pipe Bends—A. M. Wahl.

TUESDAY AFTERNOON, DECEMBER 6, 2:00 P. M

JOINT SESSION WITH A. S. R. E.

Heat Transfer, General Formulas—Edwin R. Cox.

How Shall Heat Transmission in Walls Be Measured—F. G. Hechler.
Effect of Pipe Lengths on Orifice Coefficients—A. J. Wood.

HYDRAULIC

Centrifugal Pumps—Herbert T. Davey.
New Method of Separating the Hydraulic Losses in a Centrifugal Pump—Michael D. Aisenstein.
Method of Analyzing Performance Curves of Centrifugal Pumps—Jos. Lichtenstein.

WEDNESDAY MORNING, DECEMBER 7, 9:30 A. M.

The K. S. G. Process of Low-Temperature Carbonization—Walter Runge.
Progress Report—R. T. Haslam.
Present Applications of Photography in Mechanical Engineering—C. E. K. Mees.
Photomicrography and Its Application to Mechanical Engineering—F. F. Lucas.
X-Ray Photography and Its Application to Mechanical Engineering—W. P. Davey.

WEDNESDAY AFTERNOON, DECEMBER 7, 3:00 P. M.

Principles of Apprenticeship Organization—Ben S. Moffatt.
Steam Tables Research—Reports from Bureau of Standards and M. I. T.

THURSDAY MORNING, DECEMBER 8, 9:30 A. M.

Short-Time Tensile and Expansion Tests on Plain Carbon Steels and Enduro Metal at Elevated Temperatures—A. E. White and C. L. Clark.
Some Factors in Furnace Design for High Capacity—E. G. Bailey.
Some Operating Data for Large Steam-Generating Units—Henry Kreisinger and T. E. Purcell.

THURSDAY AFTERNOON, DECEMBER 8, 2:00 P. M.

Viscosity of Lubricants under Pressure—M. D. Hersey and H. Shore.
The Effect of Running in on Journal-Bearing Performance—S. A. McKee.
An Investigation of the Performance of Waste-Packed Armature Bearings—G. B. Karelitz.
Progress Report of Executive Committee with Outline of Plan and Scope for Future Work—S. T. Powell.
Progress Reports of Sub-Committees of Joint Research Committee on Boiler Feed Water Studies.
Design and Operation of Deconcentrators and Continuous Blowdown Apparatus—R. C. Bardwell.
Water Softening by Chemicals, with Special Reference to Combined System—C. R. Knowles.
Studies on Priming and Foaming of Boiler Waters with Special Reference to Railroad Practice—C. W. Foulk.
Corrosion of Boilers and Appurtenances, and Plan and Scope of Future Work—F. N. Speller.
The Effect of Industrial Wastes on the Boiler-Feedwater Problems and Condenser Operation—V. B. Siems.
Standardization of Water Analyses with Recommendations for the Determination of Dissolved Oxygen, CO_2 and Hydrogen-ion Concentration—Harold Farmer.
Bibliography of Boiler Feed Water with a Review of the Work During the Past Year—George A. Stetson.
Parallel Operation Between Alternating Current Generators—J. W. Morton and C. Juul.
Efficiencies of Otto and Diesel Engines—F. O. Ellenwood, F. C. Evans and C. T. Chwang.

On Tuesday afternoon at 4:30 P. M., W. E. Wickenden will deliver an address on "What the National Engineering Societies Can Do for Engineering Education." On Tuesday evening at 8:30 P. M. will be held the presidential address and reception and the award of the Melville Medal to L. P. Alford.

News Notes

R. H. BEAUMONT Co., Philadelphia, Pa., announces that George T. Birch, recently with the home office, has been appointed district manager of the Detroit territory with office at 901 Kresge Bldg., Detroit, Mich.

SPRAY ENGINEERING Co., Boston, Mass., announces with deep regret the death on October 20, 1927, of J. Jarvis Preble, who has been associated with this company 14 yr., the last two of them as vice president.

WALWORTH Co., Boston, Mass., has appointed the James E. Degan Co., 622-24 First St., Detroit, Mich., as a distributor of Walworth valves.

H. M. BYLLESBY & Co. announces the removal of its Boston office from 14 State St. to new and larger quarters at No. 1 State St., Boston, Mass.

HILLS-MCCANNA Co. announces that its new address is 2349-59 Nelson St., Chicago, Ill., where a new plant has been built that gives approximately double the capacity of its former plant. The telephone numbers for the new plant are Wellington 0020-21-22-23.

THE FALK CORP., Milwaukee, Wis., has made arrangements with William Kennedy & Sons, Ltd., Owen Sound, Ontario, whereby the latter company is to manufacture and sell Falk continuous tooth herringbone gears, speed reducers and flexible couplings in Canada.

STONE & WEBSTER, INC., 49 Federal St., Boston, Mass., is accepting bookings for the two-reel film, "From Coal to Electricity," prepared for those who are interested in knowing how electricity is produced in modern power stations. The picture not only shows the equipment in the station but also visualizes the operation of each machine. In addition to this, a two-reel film, "Conowingo," describing the 600,000-hp. hydro-electric development on the Susquehanna River, will be released by Stone & Webster about November 15. This development is being carried out by The Philadelphia Electric Power Co.

PUBLIC SERVICE ELECTRIC & GAS Co., Newark, N. J., has completed a new switching station at Trenton, N. J.

THE MORSE CHAIN Co., Ithaca, N. Y., announces the appointment of Harry E. Matthews as manager of its Charlotte, N. C., office, to fill the vacancy caused by the death of George W. Pritchett on September 15.

WHITING CORP., Harvey, Ill., announces the sudden death of its vice president and director of sales, Norman Spear Lawrence, who died Wednesday morning, October 26, after a brief attack of pneumonia. Mr. Lawrence was a graduate of Cornell University, class of '04, and has served the company in various capacities since that time.

D. H. SKEEN & Co., 1362 Monadnock Block, Chicago, Ill., announces its incorporation; this organization was formerly a partnership. Under the new incorporation all stock is owned within the organization. The officers are D. H. Skeen, president; G. L. Dickson, vice president; P. L. Richtmyer, treasurer; and E. A. Bauer, secretary.

O. E. FRANK HEATER & ENGRG. Co., 20 Milburn St., Buffalo, N. Y., announces that C. K. Bennett of Tulsa, Okla., formerly heat transfer expert for Schutte & Koerting Co., has joined its organization, and is located at the home office in Buffalo.

THE HENDRICK MFG. Co., Carbondale, Pa., has appointed the following representatives: J. E. Beattie, Greenville, S. C.; Boiler Equipment Service Co., Candler Bldg., Atlanta, Ga.; Latex Steel & Machinery Co., San Jacinto Life Bldg., Beaumont, Tex.; W. A. Sedwick Co., 401 Construction Bldg., Dallas, Tex.

WESTERN UNITED GAS & ELECTRIC Co., Joliet, Ill., passed into direct management of its own officers, Nov. 1, with the cancellation of the contract with the General Engineering Management; John F. Egolf, until recently general manager for the Chicago, North Shore & Milwaukee Rail Road, became operating vice president, succeeding B. E. Waltz. Other officers of the Western United Corporation, the Western United Gas & Electric Co., Aurora, Elgin & Fox River Electric Co. and the Coal Products Manufacturing Co., the utilities corporations involved, are unchanged except for the inclusion of Mr. Egolf. The officers are: I. C. Copley, president; B. P. Alschuler, vice president and general counsel;

W. M. Willett, general manager; Roy N. Dreiman, treasurer; Charles B. Bliss, secretary.

E. L. Lundgren has been made chief engineer of the company; Fred Pierce, formerly superintendent of electric distribution has been made electrical engineer to succeed C. F. Geiger; John O'Connell, district manager, has been advanced to superintendent of electric distribution and Carl Carlson, manager of the Joliet district has been returned to Aurora as district manager. Several shifts and promotions were made in district executive offices.

UNITED STATES CIVIL SERVICE COMMISSION, Washington, D. C., announces the following open competitive examinations: Engineer, $3800; Associate Engineer, $3000; Assistant Engineer, $2400. Applications for these must be on file with the Commission at Washington not later than December 13. The examinations are to fill vacancies in the Interstate Commerce Commission for duty in Washington, D. C., or in the field and in positions requiring similar qualifications. Competitors will not be required to report for examination at any place, but will be rated on their education, training, experience and fitness. Full information may be obtained from the Commission at Washington or from the secretary of the U. S. Civil Service Board of Examiners at the post office or customs house in any city.

Books and Catalogs

PROCEEDINGS of the Iowa Power Conference held March 30 and 31, 1927, at Iowa City, under the auspices of the College of Engineering and the Extension Division of the University of Iowa, has been published as Extension Bulletin No. 170. All papers and discussions are given and, in addition, a large scale folded map showing all steam, hydro and oil engine generating stations, both private and municipally owned and all transmission lines of 2200 v. and over is included. The bulletin measures 6 by 9 in., contains 165 pages and sells for $1.00.

IN BULLETIN B-1, the Elliott Co., Jeannette, Pa., describes unaflow, 4-valve and single valve engines of its manufacture. These are a product of the Ridgway Works of Elliott Co., and the bulletin discusses details and applications of them besides giving considerable engineering data on steam consumption and design of the units.

Elliott Co. is also issuing Bulletin L, a 16-page bulletin in two colors, on synchronous motors. This contains, besides details of the construction and application of Elliott synchronous motors, considerable data on the use of synchronous motors for power factor correction.

THE TERRY STEAM TURBINE CO., Hartford, Conn., has just issued Bulletin S-84, a 40-page illustrated discussion concerning the Terry turbine. Data regarding the development of the company are given, together with an illustrated discussion of the construction of the Terry turbine, and many interesting photographs of installations.

MCCLAVE-BROOKS CO., Scranton, Pa., in a recent 8-page illustrated bulletin, describes the McClave No. 3 shaking grate for both low and high pressure boilers, especially adaptable to schools, apartment houses, public buildings and the like.

AMERICAN DISTRICT STEAM CO., North Tonawanda, N. Y., has issued bulletin 201, which describes and illustrates Adsco expansion devices and methods of applying them. Details of the devices are illustrated and tables of dimensions are given.

THE DAMPNEY CO. OF AMERICA has issued an interesting treatise on the use of protective coatings on power plant equipment and the method of applying to the interior of boilers and boiler tubes. It gives the experience of many central stations and industrial plants with this method of preventing corrosion and pitting while lessening scale formation and adherence. Copies may be had by writing the above company at Hyde Park, Boston, Mass.

IN AN INTERESTING folder illustrating Cameron steam pumps, the Ingersoll-Rand Co. shows details of internal construction of the single-stage, double-suction type and illustrates the uses to which these pumps may be adapted.

ELLIOTT CO., Jeannette, Pa., in bulletin D-2, describes Elliott Feed-Water Heaters of all types. Photographs and drawings of details are shown, together with comments on the operation and photographs of installations.

RELIANCE INDUCTION motors with ball bearings for two and three-phase alternating current circuits are described in Bulletin No. 102 recently issued by the Reliance Electric & Engineering Co., Ivanhoe Road, Cleveland, Ohio.

THE BRADY CONVEYORS CORP., 20 W. Jackson Blvd., Chicago, in bulletin No. 23 describes various types of pneumatic conveyors for handling ash, coke and other materials.

JOHNS-MANVILLE CORP., 292 Madison Ave., New York City, in a recent bulletin, describes its new product, Superex insulation for furnaces and other high temperature equipment.

THE AJAX FLEXIBLE COUPLING CO., Westfield, N. Y., has just issued a new general bulletin describing the Ajax industrial shock absorber.

DURAMETALLIC CORP., Kalamazoo, Mich., in a 24-page illustrated booklet, describes all types of Durametallic packings and gaskets.

THE DIRECT SEPARATOR CO., Inc., Syracuse, N. Y., in catalog S-24, just issued, describes its separators for removing oil and water from steam, compressed air and the like.

REFINEMENTS of the new Bessemer Diesel engine, of eight cylinders in block type are described in a pamphlet issued by the Bessemer Gas Engine Co., 20 Lincoln Ave., Grove City, Pa.

PAIGE & JONES CHEMICAL CO., Hammond, Ind., has just issued a 28-page well illustrated bulletin entitled "Softened Water—The Universal Need." This details the various benefits derived from softening water, gives considerable data regarding the chemistry of softening and describes the different types of equipment for this purpose manufactured by this company.

HENSZEY DE-CONCENTRATOR CO., Watertown, Wis., in a bulletin just issued, describes and illustrates the Henszey continuous blowdown system designed to permit relatively large blowdown without loss of heat and to keep this blowdown automatically in proportion to the amount of impurities introduced.